NORTH ATLANTIC TREATY ORGANIZATION

SCIENCE AND TECHNOLOGY ORGANIZATION

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STO TECHNICAL REPORT **TR-MSG-100**

M&S Resource Discovery and Access

(Communication des ressources de M&S et accès à ces ressources)

Work performed by the NATO Modelling and Simulation Group (NMSG) MSG-100.

Published December 2016

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The NATO Science and Technology Organization

Science & Technology (S&T) in the NATO context is defined as the selective and rigorous generation and application of state-of-the-art, validated knowledge for defence and security purposes. S&T activities embrace scientific research, technology development, transition, application and field-testing, experimentation and a range of related scientific activities that include systems engineering, operational research and analysis, synthesis, integration and validation of knowledge derived through the scientific method.

In NATO, S&T is addressed using different business models, namely a collaborative business model where NATO provides a forum where NATO Nations and partner Nations elect to use their national resources to define, conduct and promote cooperative research and information exchange, and secondly an in-house delivery business model where S&T activities are conducted in a NATO dedicated executive body, having its own personnel, capabilities and infrastructure.

The mission of the NATO Science & Technology Organization (STO) is to help position the Nations' and NATO's S&T investments as a strategic enabler of the knowledge and technology advantage for the defence and security posture of NATO Nations and partner Nations, by conducting and promoting S&T activities that augment and leverage the capabilities and programmes of the Alliance, of the NATO Nations and the partner Nations, in support of NATO's objectives, and contributing to NATO's ability to enable and influence security and defence related capability development and threat mitigation in NATO Nations and partner Nations, in accordance with NATO policies.

The total spectrum of this collaborative effort is addressed by six Technical Panels who manage a wide range of scientific research activities, a Group specialising in modelling and simulation, plus a Committee dedicated to supporting the information management needs of the organization.

- AVT Applied Vehicle Technology Panel
- HFM Human Factors and Medicine Panel
- IST Information Systems Technology Panel
- NMSG NATO Modelling and Simulation Group
- SAS System Analysis and Studies Panel
- SCI Systems Concepts and Integration Panel
- SET Sensors and Electronics Technology Panel

These Panels and Group are the power-house of the collaborative model and are made up of national representatives as well as recognised world-class scientists, engineers and information specialists. In addition to providing critical technical oversight, they also provide a communication link to military users and other NATO bodies.

The scientific and technological work is carried out by Technical Teams, created under one or more of these eight bodies, for specific research activities which have a defined duration. These research activities can take a variety of forms, including Task Groups, Workshops, Symposia, Specialists' Meetings, Lecture Series and Technical Courses.

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List of Acronyms

ACT	Allied Command Transformation
CAC	Common Access Card
CIO	Chief Information Officer
CM	Configuration Management
COI	Community of Interest
CONOPS	Concept of Operations
CSO	Collaboration Support Office
DDMS	DoD Discovery Metadata Specification
DISA	Defense Information Systems Agency
DMS	Discovery Metadata Specification
DMWG	Data Management Working Group
DND	Canadian Department of National Defence
DoD	Department of Defense
DSE	Data Services Environment
EA	Executive Agent
ESR	Enterprise Service Registry
GIG	Global Information Grid
HLA	High Level Architecture
IT	Information Technology
JCIDS	Joint Capabilities Integration Development System
LIME	Local Inventory Metadata Engine
M&S	Modeling and Simulation
MDR	Metadata Registry
MOU	Memorandum Of Understanding
MSC-DMS	M&S COI Discovery Metadata Specification
NATO	North Atlantic Treaty Organization
NC3A	NATO Consultation, Command and Control Agency
NC3B	NATO Consultation, Command and Control Board
NCDS	Net-Centric Data Strategy
NCE	Net-Centric Environment
NCES	Net-Centric Enterprise Services
NCP	Net-Centric Publisher
NDA	NHQC3S Data Administration
NDAG	NATO Data Administration Group
NDMS	NATO M&S Discovery Metadata Specification
NHQC3S	NATO Headquarters Consultation, Command and Control Staff
NIEM	National Information Exchange Model
NII	Networking and Information Infrastructure
NMRR	NATO Metadata Registry and Repository
NMSG	NATO Modelling & Simulation Group

NMSMP	NATO M&S Master Plan
NNEC	NATO Network-Enabled Capability
NSRL	NATO Simulation Resource Library
NXMLSWG	NATO XML Management Services Working Group
PfP	Partnership for Peace
Pgm	Program
PKI	Public Key Infrastructure
PMO	Program Management Office
POC	Point Of Contact
PoR	Program of Record
PPBE	Planning, Programming, Budgeting and Execution
R&D	Research and Development
RTO	Research and Technology Organisation
SD	Service Discovery
SE	Synthetic Environment
SECO	DND Synthetic Environment Coordination Office
SME	Subject Matter Expert
STO	Science and Technology Organization
UIMA	Unstructured Information Management Architecture
U.S./USA	United States of America
USD-AT&L	Undersecretary of Defense – Acquisition, Technology, and Logistics
WAN	Wide Area Network
WG	Working Group
WSDL	Web Services Description Language
XACML	eXtensible Access Control Mark-up Language
XMI	XML Metadata Interchange
XML	Extensible Mark-up Language
XMLSWG	NATO XML Management Services Working Group

Glossary

Access	To interact with a system entity to manipulate, use, gain knowledge of, and/or obtain a representation of some or all of a system entity's resources.
Access Control	Protection of metadata assets against unauthorized access; a process by which the use of metadata assets is regulated by a security policy and is permitted only by authorized entities according to that policy.
Authoritative	Recognized by appropriate governing authorities to be valid, trusted or distinguished as preferred (e.g., the United States Postal Service is the authoritative source for U.S. mailing ZIP codes).
Business Process	The complete chain of actions and responses that are undertaken by some entity to provide a product and/or service for users. A business process entails the execution of a sequence of one or more process steps. It should have a clearly defined deliverable or outcome. A business process is defined by the business event that triggers the process, the inputs and outputs, all the operational steps required to produce the output, the sequential relationship between the process steps, the business decisions that are part of the event response, and the flow of material and/or information between process steps.
Community Of Interest (COI)	A collaborative group of users who must exchange information in pursuit of their shared goals, interests, missions, or business processes and who therefore must have shared vocabulary for the information they exchange. COIs are organizing constructs created to assist in implementing net-centric information sharing. Their members are responsible for making information visible, accessible, understandable, and promoting trust; all of which contribute to the data interoperability necessary for effective information sharing.
Core Enterprise Services	That small set of globally accessible services, whose use is mandated to provide Enterprise-wide awareness of, access to and delivery of information on the GIG that is understandable, trustworthy, responsive, and interoperable.
Data Asset	Any entity that is composed of data. For example, a database is a data asset that comprises data records. A data asset may be a system or application output file, database, document, or web page. A data asset also includes a service that may be provided to access data from an application. For example, a service that returns individual records from a database would be a data asset. Similarly, a website that returns data in response to specific queries (e.g., www.weather.com) would be a data asset. A human, system, or application may create a data asset (DoD Dir 8320.02). For more details, see Data Assets page for more detail.
Data Producer or Provider	Refers to a program, an organization (government and/or commercial), a person, or even a machine process that controls, manufactures, and/or maintains data assets within the Department, other government activities in the National Security Arena, as well as Allied/Coalition Partners. Data providers include operators and supporting developers who use resources provided by DoD programs of record to create and/or expose data to significant audiences.

End User	End users are all those persons or machines which can directly access services on the GIG, including Core Enterprise Services such as Portal, Content Discovery and Delivery, and Service Discovery and Registration. End users include both information producers and consumers.
Federation	Federation is what lies between total integration and "stovepipes". A federation is a collection of cooperating component information systems, services or capabilities, which are autonomous and heterogeneous in varying degrees. Three important attributes of a federation are partial autonomy, heterogeneity and distribution. Another dimension required of federations is a Networking Environment (net-centricity), wherein multiple systems can share selected data over a WAN to support related functions within federation participants. Through relatively loose collective governance arrangements, federations define a framework for interaction, specific sets of interconnections, and transactions that minimize the need for central authority yet support sharing and coordination among participating systems where mutual interests converge.
Interoperability	The ability of systems, units or forces to provide service to and accept services from other systems, units or forces and to use the services so exchanged to enable them to operate effectively together.
Information Sharing	Making information available to participants (people, processes, or systems). Information sharing includes the cultural, managerial, and technical behaviors by which one participant leverages information held or created by another participant. (DoD Information Sharing Strategy). See Information Sharing for more details.
Mission Area	A defined area of responsibility with functions and processes designed to accomplish a certain class of objectives. In the context of managing the DoD's GIG Investment Portfolios, the DoD has identified four major mission areas – the Warfighting Mission Area, the Business Mission Area, the Defense Intelligence Mission Area, and the Enterprise Information Environment Mission Area.
Net-Centric Environment (NCE)	The Net-Centric Environment is a framework for full human and technical connectivity and interoperability that allows all DoD users and mission partners to share the information they need, when they need it, in a form they can understand and act on with confidence; and protects information from those who should not have it. (Net-Centric Environment Joint Functional Concept, Version 1.0, April 7, 2005).
Ontology	An explicit specification of how to represent the objects and concepts that exist in some area of interest and of the relationships that pertain among them.
Schema	A diagrammatic representation, an outline, or a model. In relation to data management, a schema can represent any generic model or structure that deals with the organization, format, structure, or relationship of data. Some examples of schemas are: 1) A database table and relational structure; 2) A document type definition; 3) A data structure used to pass information between systems; and 4) An XML schema document that represents a data structure and related information encoded as XML. Schemas typically do not contain information specific to a particular instance of data.

Service	A mechanism to enable access to one or more capabilities, where the access is provided using a prescribed interface and is exercised consistent with constraints and policies as specified by the service description.
Service Provider	An entity (i.e., person or organization) that offers the use of information capabilities by means of a service. For NCES: developers (government or commercial) that support DoD programs of record and have applications that provides their own services to the enterprise.
Service Consumer	For NCES: developers (government or commercial) that support DoD programs of record and have applications that use/interface with the services provided by NCES.
Semantic Metadata	Information about a data asset that describes or identifies characteristics about that asset that convey meaning or context (e.g., descriptions, vocabularies, taxonomies).
Tagging	The association of discovery metadata with data assets, also referred to as data tagging within the context of the NCDS data visibility goal. Data visibility is enhanced through the use and publication of discovery metadata that describe data assets. The implementation of data tagging mechanisms may vary by data asset and granularity of description.
Taxonomy	Provides categorizations of related terms. In doing so, they make use of class/sub-class relationships (i.e., they are hierarchical in conveying the relationships between categories). Taxonomies are important to ensuring that data assets are properly categorized and that searches of discovery metadata and the content that they characterize are well targeted.
Vocabulary	Represents agreements on the terms and definitions common to the COI, including data dictionaries. For example, one COI might define the term “tank” to mean a pressurized vessel, whereas another might define “tank” to mean a tracked vehicle. Both definitions are acceptable, but the user must understand these definitions, and their context, to properly use the data.
Workflow	A representation of the flow of interactive tasks in a process and its related sub-processes; including specific activities, information dependencies, and the sequence of decisions and activities.

Preface

This study on M&S Resource Discovery and Access was conducted from April 2012 to April 2014 by members of the NATO Modelling and Simulation Group – 100 (NMSG-100). Several meetings were held during this period and successful proofs of concept were performed by the United States and Canada. The NMSG Chairman during the conduct of this study was Mr. Wim Huiskamp, TNO Defence, Security and Safety. The NMSG-100 Chairman was Mr. John Moore, Deputy Assistant Secretary of the Navy (DASN), Research, Development Test, and Evaluation (RDT&E), Navy Modeling and Simulation Coordination Office (NMSO). Mr. Frank Mullen served as technical point of contact for the DoD Modeling and Simulation Coordination Office. Contributors to this technical report and Task Group Members are listed on pages xiii and xiv.

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M&S Resource Discovery and Access

(STO-TR-MSG-100)

Executive Summary

NATO Member and Partner Nations require enhanced Modeling and Simulation (M&S) capabilities, even as the funding needed to develop data and acquire technology declines. One solution is to develop an improved capability to discover and reuse existing M&S resources to meet the increasing demand. MSG-100 was established to review resource discovery and access issues and provide recommendations for improved M&S reuse. The Task Group was chaired by the United States and consisted of the following participating Nations:

- Canada;
- France;
- Turkey;
- United Kingdom; and
- United States.

Two proofs of concept involving the development and publication of metadata to catalogs, registries, and repositories were successfully demonstrated. The United States Department of Defense's Data Services Environment is a fully functional and operational system that uses a centralized registry and repository and an Enterprise Catalog to search and discover information about available resources. It is used in this report as an example of the types of processes, procedures, roles and responsibilities that must be performed to implement a NATO solution. In addition, Canada demonstrated, and continues to mature, a promising technology that suggests a decentralized network of NATO Member metadata centers should also be evaluated. While it is unlikely that a single technical solution will satisfy all the needs of each NATO Nations, it is evident that a technical solution is achievable. Equally important, and perhaps more challenging, are the non-technical aspects of advancing NATO M&S interoperability, including the business and governance processes, as well as new policy development and international agreements needed to share tools, data and services efficiently and maximize cost savings through reuse of existing capabilities. This report summarizes technical, managerial, and infrastructure components of M&S discovery and access, including best practices and lessons learned, and recommendations follow on efforts to:

- Develop an active and effective NATO MSG Community Of Interest (COI) to address reuse;
- Promote the adoption of an M&S discovery metadata standard;
- Update NATO's M&S Discovery Metadata Specification (NDMS);
- Develop and employ business models to promote M&S reuse;
- Enhance the NATO Simulation Resource Library (NSRL); and
- Mature the NSRL interface specification.

Communication des ressources de M&S et accès à ces ressources

(STO-TR-MSG-100)

Synthèse

Les pays membres et partenaires de l'OTAN ont besoin de capacités améliorées de modélisation et de simulation (M&S), même si le financement nécessaire au développement des données et à l'acquisition des technologies diminue. Une solution consiste à développer une capacité améliorée afin de communiquer et réutiliser les ressources de M&S déjà existantes pour répondre à la demande croissante. Le MSG-100 a été créé dans le but d'étudier les problèmes de communication et d'accès aux ressources et d'émettre des recommandations pour une meilleure réutilisation de la M&S. Le groupe de travail était présidé par les Etats-Unis et se composait des pays suivants :

- Canada ;
- France ;
- Turquie ;
- Royaume-Uni ; et
- Etats-Unis.

Deux validations de principe impliquant le développement et la publication de métadonnées dans des catalogues, bases de registre et référentiels ont été réalisées avec succès. L'environnement des services informatiques du ministère de la Défense des Etats-Unis est un système pleinement fonctionnel et opérationnel qui utilise une base de registre et un référentiel centralisés et un catalogue d'entreprises permettant de rechercher et communiquer des informations sur les ressources disponibles. Il illustre dans ce rapport les types de processus, procédures, rôles et responsabilités qui doivent être mis en œuvre dans une solution OTAN. Par ailleurs, le Canada a fait la démonstration d'une technologie prometteuse, qu'il continue de faire évoluer, suggérant qu'il faudrait également évaluer un réseau décentralisé de centres de métadonnées des membres de l'OTAN. Bien qu'il soit improbable qu'une seule solution technique satisfasse tous les besoins de chaque pays de l'OTAN, il est évident qu'une solution technique est réalisable. Les aspects non techniques des progrès de l'interopérabilité de M&S au sein de l'OTAN sont tout aussi importants et peut-être plus compliqués. Il s'agit des processus administratifs et de gouvernance, de l'élaboration de nouvelles politiques, ainsi que des accords internationaux qui sont nécessaires au partage efficace d'outils, de données et de services et à la maximisation des économies par la réutilisation des capacités existantes. Ce rapport résume les composantes techniques, managériales et infrastructurelles de la communication et de l'accès à la M&S, notamment les meilleures pratiques et les leçons retenues, et émet des recommandations de suivi pour :

- Développer une communauté d'intérêts autour du MSG de l'OTAN, active et efficace, qui s'occupe de la réutilisation ;
- Promouvoir l'adoption d'une norme de métadonnées de communication de la M&S ;
- Mettre à jour la spécification des métadonnées de communication de la M&S (NDMS) ;
- Développer et employer des modèles opérationnels qui promeuvent la réutilisation de la M&S ;
- Améliorer la bibliothèque des ressources de simulation de l'OTAN (NSRL) ; et
- Affiner la spécification d'interface de la NSRL.

Chapter 1 – INTRODUCTION

There have been several significant developments in NATO M&S resource discovery and access recently. However, as this report documents, there is also much remaining work to do to establish a functional capability to discover and reuse M&S resources. After summarizing the origins of the MSG-100 effort, this chapter provides a project background, specific NMSG-100 objectives, and a brief introduction to metadata and its relationship to data and information. Following the introduction, it goes on to describe key organizations, roles and responsibilities, and then metadata processes, procedures, and best practices. Then, after presenting lessons learned, this report concludes with a set of recommendations. These recommendations apply to:

- Discovery metadata standards and specifications;
- Business and COI initiatives; and
- NSRL enhancements.

1.1 BACKGROUND

The NATO M&S Master Plan (NMSMP) [19] defines the NATO M&S vision, guiding principles, and primary M&S application areas. The NATO M&S vision is stated as exploiting M&S fully across NATO and its Member Nations to enhance operational and cost effectiveness. Guiding principles include M&S information and data synergy, interoperability, reuse, and affordability. Support to operations, mission rehearsal, training and education, capability development, and procurement are among the primary NATO M&S application areas. Among the objectives of the NMSMP is the establishment of a common technical framework to advance and promote interoperability and reuse. A recognized central catalog is essential in achieving these goals and objectives.

In 2008, NATO'S Allied Command Transformation (ACT) funded several projects with the goal of refining the requirements and developing a specification for an operational use Metadata Registry (MDR). Simultaneously, the NATO Consultation, Command and Control Board (NC3B) funded a project with the NATO Consultation, Command and Control Agency (NC3A) (combined with NATO Communications and Information Agency in 2012) for the development of an administrative MDR. Together these projects contributed to the definition and specifications for the NATO Metadata Registry and Repository (NMRR). A NATO-owned NMRR is required to support NATO COIs and to foster interoperability on NATO operations. As the designated supervisor of the NATO Modelling and Simulation Master Plan (NMSMP), the NMSG is responsible for incorporating the use of the NMRR into the plan's governance and guidance.

In keeping with the interoperability goals of the NATO Network-Enabled Capability (NNEC) [15], the purpose of the NMRR is to provide a federated capability where discovery, structural, and semantic metadata can be registered, shared and reused, in order to make it available to NATO Nations and other organizations in a secure environment. Consequently, employment by a broad range of users contributes to the Interoperability Standardization process. The data configuration, lifecycle, and vocabulary housed within the NMRR are to be managed by an administrative user via direct interface. Operational users will have only indirect interaction with the registry.

The development of the NMRR was accomplished in part as the result of a NATO/DISA Memorandum Of Understanding (MOU) [16] on Extensible Mark-up Language (XML) registration relative to M&S [17]. This MOU describes how to:

1) Govern NATO processes for XML Registration in the DoD Metadata Registry.
2) Generate, submit, and manage NATO submissions to the DoD Metadata Registry.
3) Develop and maintain procedures for harmonizing the NATO Namespace and facilitate specific harmonization efforts with DoD where appropriate.
4) Coordinate with appropriate NATO security organizations to address DoD Metadata Registry access controls.

This document supports the objectives of the NATO Modelling and Simulation Group (NMSG). The mission of the NMSG is to promote cooperation among Alliance bodies, NATO Nations and PfP Nations to improve the use of M&S. Primary mission areas include M&S standardization, education, and science and technology. Of the five primary objectives of the NMSG, the first is to "Establish a Common Technical Framework to Foster Interoperability and Re-Use".

The NATO Modelling & Simulation Group (NMSG) is similar to the other six Panels in the NATO Science and Technology Office (STO) and is composed of members from NATO Nations. The Group is responsible for proposing and managing the scientific work program in the field of M&S research, as well as the establishment and application of education, training and standardization. In addition the NMSG has delegated authority from CNAD for the establishment of NATO M&S standards [18]. The MSG-100 is part of the Collaboration Support Office (CSO) which is one of the 3 executive bodies of the Science and Technology Organization (STO) (Figure 1-1).

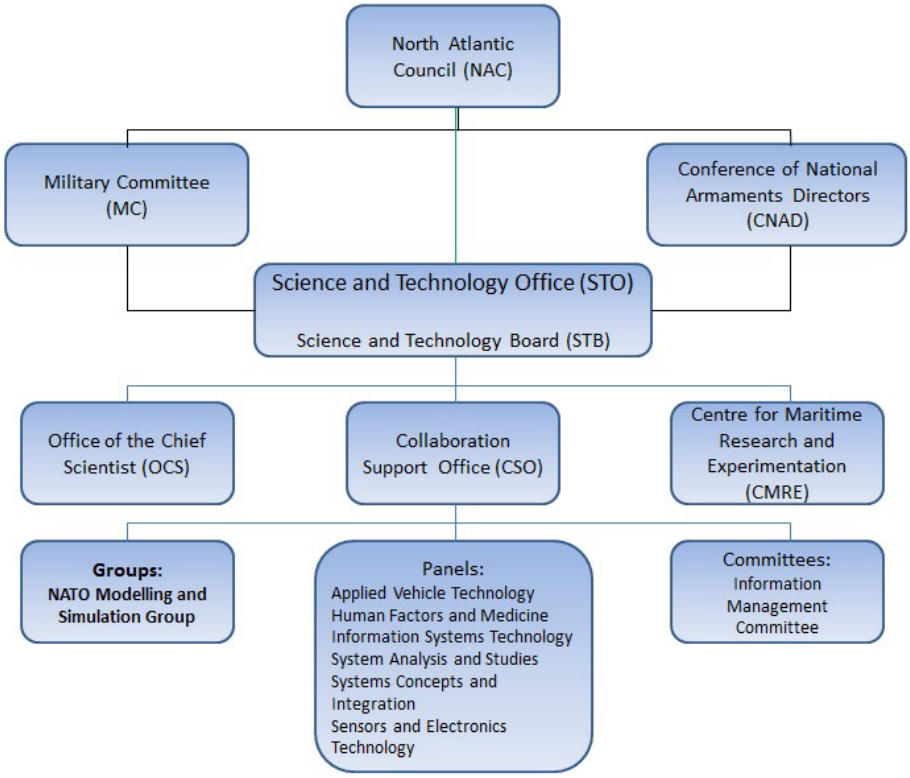

Figure 1-1: NATO MSG-100 Organizational Chart.

1.2 PURPOSE AND SCOPE

The primary purpose of this report is to document progress toward achieving the objectives of MSG-100 and becoming an M&S metadata-specific instantiation of the NATO Network-Enabled Capability (NNEC). The stated objectives of the MSG-100 are to:

1) Produce a NATO M&S Discovery Metadata specification (NDMS).
2) Propose changes to the NSRL so that it can support the specification, and produce an interface specification for the modified NSRL.
3) Provide the specification and interface requirements to each Member Nation so that the Nation can access and contribute data under their cognizance to the NSRL, if it so chooses.
4) Provide a proof of concept to demonstrate the ability to add, edit and remove M&S resources or only metadata within the NATO M&S Resource Library either directly (on-line) or indirectly (by updating a national repository), depending on which approach is chosen for testing purposes.
5) Develop a set of recommendations for establishing an enduring NMSG COI which will serve as the governance body for the NATO M&S discovery metadata standard and the architecture specification and its use process that enables the exchange of metadata with the NSRL.
6) Develop a business model enabling an increased reusability level of the M&S resources.
7) Develop a strategy to promote and facilitate adoption of the M&S discovery metadata standard.

The second purpose of this report is to describe how making progress toward achieving the MSG-100's seven objectives advances NATO policy. Relative to the NNEC for instance, M&S has a key role[1]. Specifically it is stated that: "*M&S can be effectively used as a lead investment to enable the advancement and continuous evolution of NNEC both for the Alliance as a whole and individually for its member nations.*" With respect to metadata, the definition of NNEC states the "*... environment should adhere to and be able to exploit the capability of the NATO Network Information Infrastructure, including, for example: Common supporting digital infrastructure, alignment of data, metadata, and interface standards.*" This theme is continued within the NMSMP which states as one of its goals: "Reuse: Increase the visibility, accessibility, and awareness of M&S to foster sharing and ensure its best exploitation across all NATO M&S application areas." Finally, NATO's policy on metadata states: "*The enormous amount of information on NATO networks necessitates efficient and effective ways of finding, identifying, and accessing the right information at the right time. The proper application of metadata enables users to find, identify, and access relevant information more quickly and easily. The use of metadata is also fundamental to the management and sharing of information within NATO*" [20].

This report provides recommended techniques to improve how M&S resources are discovered and made available for reuse; to increase interoperability, and to enable sharing between Nations via a common core taxonomy and interface specification(s). These recommendations apply to discovery and structural metadata, as well as asset repositories. They have been developed by the members of the MSG-100 (Canada, France, Turkey, United Kingdom and United States) and are intended to be useful to all NATO and PfP members.

[1] NNEC is "the Alliance's cognitive and technical ability to federate the various components of the operational environment, from the strategic level down to the tactical levels, through a Networking and Information Infrastructure (NII)".

1.3 DATA AND METADATA

It is useful to introduce some general concepts regarding data, metadata, and information, prior to the technical discussions that follow in this report. Data is a collection of facts and is often viewed as a lowest level of abstraction from which information and knowledge are created [13]. Information is data that is organized in a meaningful way. Therefore, data, by itself, may be of limited use without applying to it some useful descriptions and properties that allow data to be quickly and easily understood and used in specific applications. Metadata, or data about data, is the descriptive, semantic, and structural information that is applied to data and other M&S resources in order to characterize them. Once properly documented, users are able to share, search, and discover data based on standards established by their domain-specific communities of interest. In the case of this study, our shared domain is NATO Modeling and Simulation Community of Interest. It is the application and adherence to metadata modeling standards that make it possible to use automated tools to rapidly expose data for discovery and reuse.

Discovery metadata provides a user with basic but critical information about the data being sought. In this case, it contains information about M&S resources, such as descriptions, location, ownership, features, and points of contact. Discovery metadata is stored in catalogs and allows potential users to find an asset as well as some insights on its features. Automated searches often target discovery metadata.

Semantic metadata is used to enhance the discoverability of data by associating it with "contextually relevant" or "domain-specific" information. This information provides greater detail about the data. Semantic Metadata associates a context with discovery metadata tags. This contextualized data can then be associated with semantic information from other user searches, resulting in a better understanding of the content that has been discovered by catalog searches.

Structural metadata is information about the rules governing data structure and format, such as schemas and transforms. By providing descriptions and relationships between a digital item's individual parts, structural metadata allows a user to display and navigate data via familiar structures and components (like columns, rows, paragraphs, and pages). Structural metadata is stored in registries and allows software engineers to write efficient and effective tools for data input, queries, and storage.

Additional amplifying information may be necessary to fully characterize M&S resources for discovery, access, and reuse and this is often accomplished with descriptive metadata. Descriptive metadata is used to describe Authoritative Data Sources, including their relationships and responsible governance authorities. Descriptive metadata is also used to explain IT services, related enterprise services, and other functional capabilities, including service definitions and specifications that can be discovered for subsequent use.

Chapter 2 – NMSG COMMUNITY OF INTEREST ORGANIZATION

A Community Of Interest (COI) is a collaborative group of users that must exchange information in pursuit of shared goals, interests, missions, or business processes, and therefore must have a shared vocabulary to allow this communication and data sharing. To achieve the level of M&S interoperability required by NATO, data about M&S assets must be visible, accessible, understandable, and trusted. These M&S resources are made visible by developing and publishing discovery metadata to a catalog system. Structural and semantic metadata about the resource are published to a registry, like the Data Services Environment (DSE), to make data understandable. Additional descriptive metadata about IT services and other enabling capabilities can also be posted to the registry. Finally, Authoritative Data Sources are registered, which allows the metadata artifacts on M&S resources to be understandable, trusted and governable.

COIs are composed of technical working groups by necessity and focused on difficult, enterprise-level data sharing and IT service issues. These working groups do not perform governance functions, like developing or publishing official NATO policy or publishing policy documents. Instead, they are typically governed by higher-level, non-technical groups such as Steering Committees and or Executive Governance Boards that oversee COI direction and progress.

2.1 ESTABLISHING AN NMSG M&S COMMUNITY OF INTEREST

In 2006, a Memorandum Of Understanding (MOU) was established between the NATO Headquarters, Consultation, Command and Control Staff and the U.S. DoD Defense Information Systems Agency (DISA). Under the auspices of this MOU (Annex A), DISA provides NATO access and storage space for the registration of unclassified metadata in a NATO Namespace created in the DISA DSE.[1] The NATO XML Management Services Working Group (XMLSWG) was tasked to be "owner" of the Namespace and a NATO Namespace Manager and an Administrator were appointed to supervise operations. The U.S. offered to "support this effort to promote the highest degree of interoperability possible between the U.S. and NATO".

In addition to establishing a NATO Namespace Manager and Administrator, an NMSG COI must be established to organize participating country Data Producers, Data Users Consumers, and End Users, as well as IT Service Providers, in order to populate the Namespace with metadata and specifically address M&S Resource Discovery and Access issues.

Lessons learned from the DoD M&S COI are given in Chapter 4 and summarize how the U.S. DoD M&S COI organized and defined operations for a data working group to address resource discovery and access.

2.2 COMMUNITY OF INTEREST ROLES AND RESPONSIBILITIES

There are a variety of roles within a functioning COI that include, but are not limited to, data and service users, producers, consumers, as well as Namespace Managers and Administrators. Each of these roles has specific responsibilities in the context of a COI. Collectively, these participants are responsible for making resources visible, accessible, understandable, and trusted, which contributes to the data interoperability environment

[1] The "DoD Metadata Registry" referenced in the NATO/DISA MOU has been deprecated. Along with other enterprise capabilities, the DoD Metadata Registry functionality was moved to the DISA Data Services Environment (DSE) in 2013. Hence, the NATO Namespace now resides in the DSE.

necessary for effective information sharing and M&S reuse. The following summary of COI responsibilities is paraphrased from the DoD DSE Concept of Operations [21].

The DSE facilitates the successful deployment and interoperation of COI capabilities and other key information sharing activities that depend on reliable metadata management capabilities. For example, discovery metadata can be developed and published to the DoD Enterprise Catalog using the DSE to make resources "visible". Structural and semantic metadata can also be published to the registries like the DSE to identify syntax and formatting rules and develop a common vocabulary for understanding M&S domain-specific terms. Descriptive metadata are used to define Authoritative Data Sources and describe web services that are available as data transport mechanisms. These different types of metadata are organized into administrative namespaces that have an assigned Namespace Manager, Namespace Administrator, and other Points of Contact that perform routine namespace oversight and management, including basic quality assessments of artifacts that are submitted. Some examples of these metadata include:

- XML schemas and sample documents;
- Web Ontology Language taxonomies;
- Data dictionaries defining domain-specific vocabularies;
- eXtensible Access Control Mark-up Language (XACML) access control files for services;
- Amplifying descriptive documents; and
- Source code.

Data Users can view domains and mission areas within the DSE, add or update COIs, and view COI links. They review existing resources for accuracy, currency, and applicability and coordinate with Namespace Managers to ensure that the status of resources in their Namespace is accurately reflected and their submissions do not duplicate other existing DSE entries. Users may search and discover all metadata published to the DSE. They can subscribe to resources posted by providers in other Namespaces and are automatically alerted to changes to resources to which they have subscribed.

Data Producers can be a program, an organization, a person, or a machine process that controls, manufactures, and/or maintains data assets within NATO, PfP, or other Allied and Coalition Partners. Producers include operators and supporting developers who use resources to create and/or expose data to NATO Members. Data Producers and Service Providers make data and applications available for use and accessible as web services. They publish metadata for discovery and provide service descriptions for understanding interfaces and semantics.

Data and Service Consumers are entities that make use of a service to meet a specific data need. Consumers may be human or machine, with service agents such as:

1) Thick clients (service-enabled Command and Control applications, for example);
2) Thin clients (web browsers); or
3) Other devices (smart phones).

Consumers use a variety of search criteria to discover both machine and human readable specifications, and choose data and designs to consume desired services.

Namespace Managers review and modify the status of submission packages in their assigned Namespace. They coordinate with users to ensure appropriate placement of newly submitted resources and ensure configuration

management of assets within the Namespace. They perform routine oversight of the Namespace; basic quality assessments of submitted artifacts; and ensure accurate status of all resources within the Namespace based on communications with Producers, Providers, developers and other users.

Namespace Registry Administrators assist Namespace Managers with the responsibilities listed in the paragraph above and have numerous additional responsibilities within the context of the DSE. Readers are directed to the DSE CONOPS for a full description of these tasks [21]. In summary, Administrators create and modify Namespaces and sub-Namespaces as requested by appropriate authorities and have authority to assign roles to those Namespaces. They create new users and systems and do those tasks necessary to manage existing users and systems. They also review and approve all submissions and facilitate metadata registration to ensure completeness.

In summary, this section of the report has discusses several technologies that are currently used for resource discovery and access, including catalogs, registries, and repositories; as well as the different types of metadata that are associated with them. Net-centric guidance states that resources to be shared by NATO should be made visible, accessible, understandable, and trusted by using these data and similar information technologies. The Data Services Environment was used as an example of a fully operational system that has been developed and deployed for use by large, global enterprises like NATO. Finally, the need for a functional NMSG COI was identified to address these technical issues was identified and the roles and responsibilities of some prominent COI participants were summarized. It is likely that a resource discovery an access solution developed for NATO applications will require some or all of these components.

Chapter 3 – METADATA ACTIVITIES

Similar to other areas of M&S software engineering, the effective development, access, and use of metadata requires implementing processes, procedures, and practices. In the best cases, these three activities support each other and provide complementary, congruent, and integrated capabilities. In the following sections, critical metadata processes, procedures, and best practices – with associated references – are provided.

3.1 PROCESSES

It is critical, in striving to achieve improved M&S resource discovery and access, to establish an implementing process. This process should have a distinct series of steps in a natural chronological progression, yet allow for constant feedback and updates (Figure 3-1) [2].

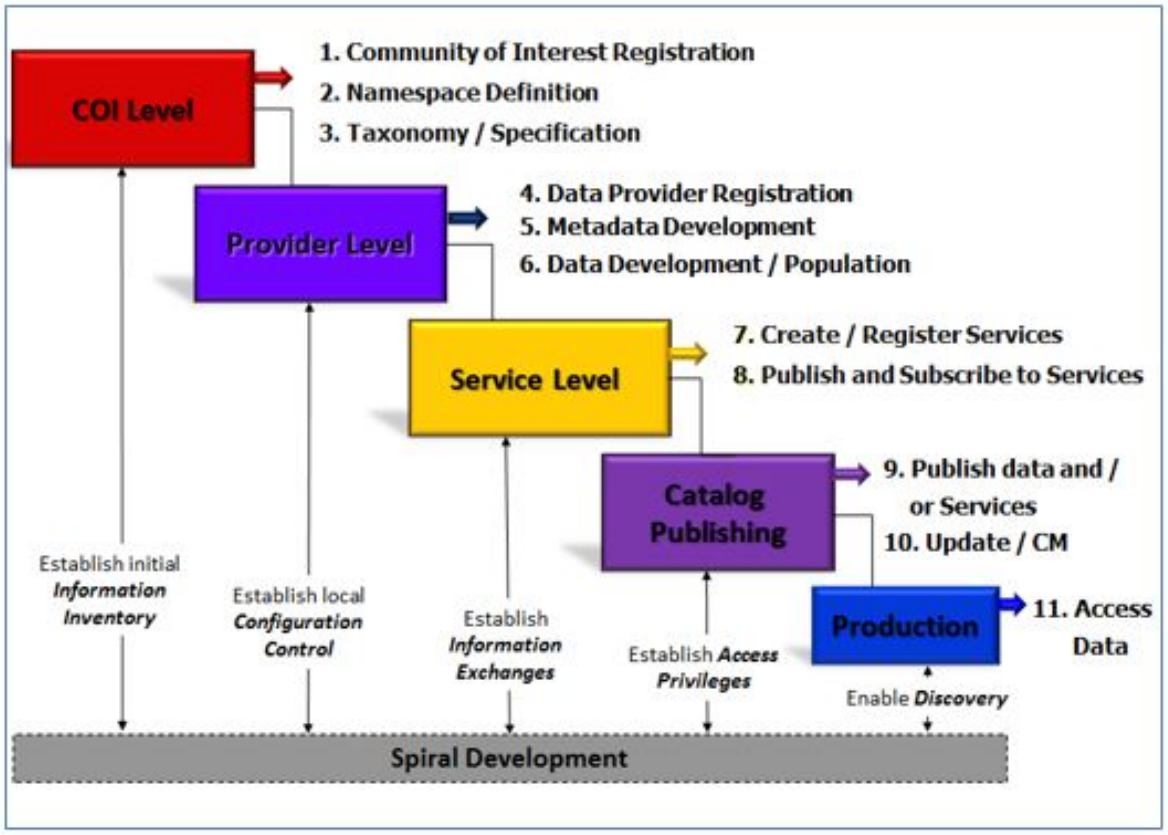

Figure 3-1: M&S Discovery Levels with Descriptions.

The primary purpose of the NMSG COI is to address M&S data sharing in a Net-Centric Environment (NCE), interface with other NATO COIs on technical issues, and to collaborate with individual countries, programs, and academic institutions that have common technical interests. In terms of metadata process, the COI establishes itself as a registered group, defines M&S-specific namespaces, and develops requisite taxonomies and specifications for enabling systems to publish discovery metadata (like a DMS).

Similarly, data providers establish their membership as registered sources, develop metadata, populate metadata structures with descriptive data on M&S sources, and develop processes for metadata maintenance. Service[1] providers also have to be registered and provide means and mechanisms to publish to and subscribe to services catalogs. Catalog publishers make available data and service descriptions as well as promoting and facilitating the use of the NDMS. Finally, production users access data for resource discovery and reuse.

In parallel with a supportive process, it is recommended to have a nominal architecture (Figure 3-2). This architecture would postulate relationships between systems, describes how data is pushed, pulled, and queried within shared spaces and from exterior points. It also delineates possible paths of data producers and consumers as well as associating NATO Discovery Catalogs and Service Registries.

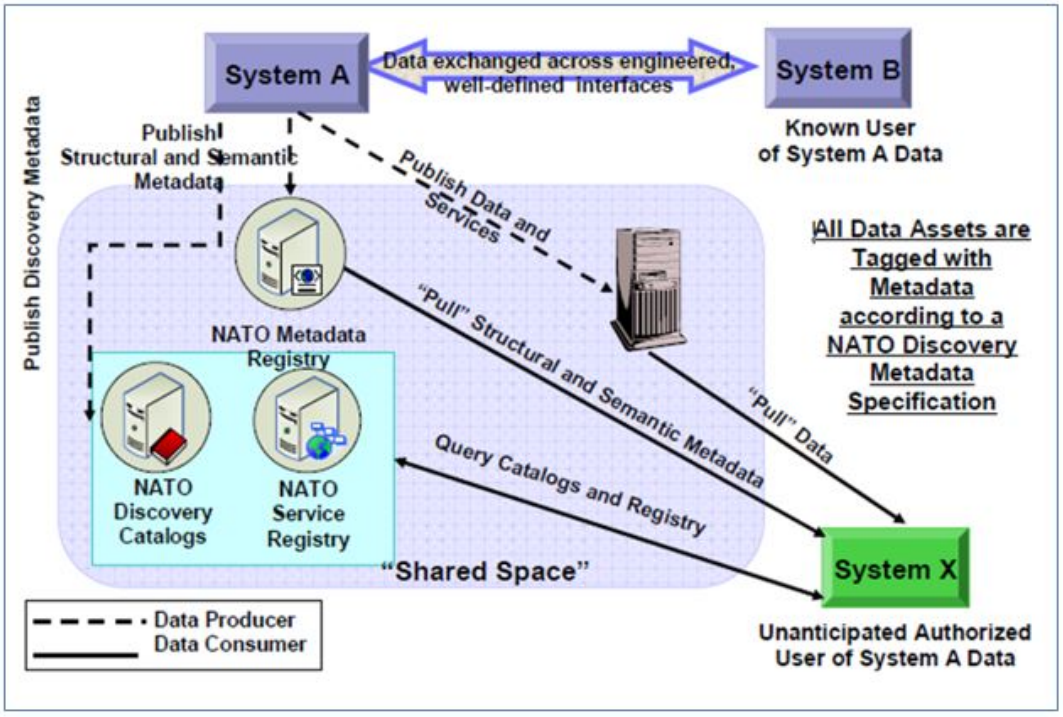

Figure 3-2: Proposed MSG-100 Architecture.

3.2 PROCEDURES

Along with a general process, a set of defined steps that describe discovery metadata identification and gathering, need to be developed (Figure 3-3). These steps take the discovery metadata practitioner from identifying the organizations with the data through creating and posting the metacard,[2] and then performing needed metadata management.

[1] Service, in this context, refers to an act/activity, functionality, or a mission-specific function that implements an action. They are the 'verbs' that take 'nouns' (data) and convert them into products.

[2] The U.S. DoD's DSE is focused on the registration, sharing, and reuse of structural, semantic, and descriptive metadata about systems, services, and data resources for the DoD, U.S. Government, and coalition partners. It serves as a repository of this metadata, and can be linked to metadata contained in other partner repositories [21].

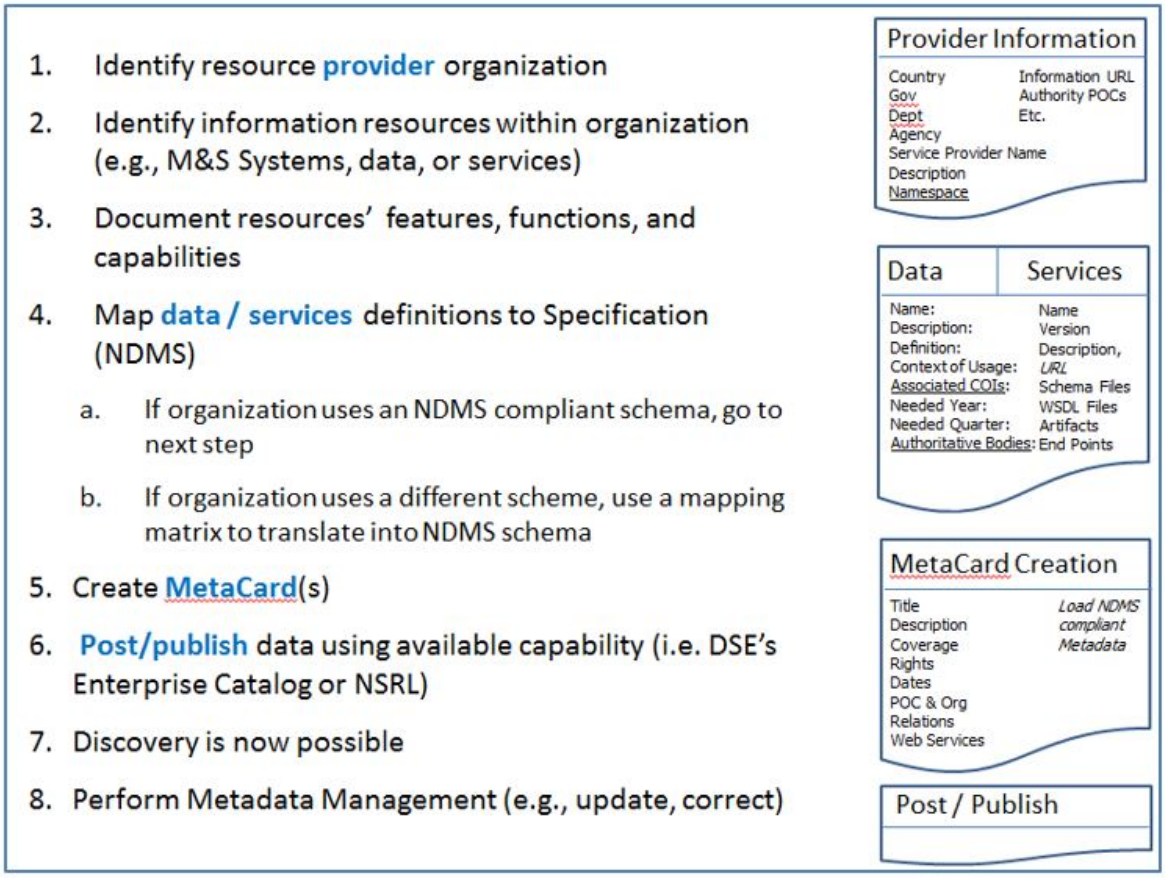

Figure 3-3: Discovery Metadata Identification and Gathering Steps.

3.3 BEST PRACTICES

Gathering, storing, and working to ensure that M&S metadata is discoverable and easy to access can benefit from well-conceived and consistently implemented actions [4]. In this case, these activities are tailored to metadata, but they are similar to those used in many data-intensive environments. The activities themselves are often listed and described in documents entitled "Codes of Best Practice" or "Best Practices Guides" since they articulate procedures that are accepted or prescribed by a community as being correct or most effective. For this discussion, these processes can usefully be broken into three categories:

- Infrastructure;
- Data; and
- Management.

In the case of metadata, the infrastructure provides the underlying ground-rules, foundational organizational structures, and fundamental management systems. It is important that they provide definitions, standards, and environments that allow some flexibility but that also ensure consistency. Best practices regarding a metadata infrastructure start with the need to:

- Define the metadata architecture or framework;
- Develop and maintain metadata standards/specifications; and
- Implement a managed metadata environment.

However, an additional part of the infrastructure that can be very important especially in M&S domains that have significant historical content, are translation capabilities (that provide consistent ways to populate current repositories with legacy metadata). It is also useful to point out that the infrastructure is likely to include security features. These features may vary greatly, but normally include user account management and access protocols as minimum. They may also grant differing types of users varying levels of access and read/write privileges.

The next area where metadata best practices can be usefully applied is to the data itself. For it to be most effective, metadata needs to be accurate, current, consistent, and well documented. This means that those populating the metadata fields must be diligent about the quality of their contributions. It is also important that they revisit the data when items change (e.g., features are enhanced, removed, merged, or similar). This is especially true for critical pieces of information, like relevant points-of-contact. In addition, especially with metadata, where it comes from – its pedigree – can be critical. The pedigree helps provide some insight into the context and quality of the data provided. So in summary, in regarding metadata it is important to:

- Create, capture, store and maintain metadata;
- Maintain metadata source data stores; and
- Extract, reconcile, integrate and share metadata.

The third and final area of applicable metadata best practices is in management and reporting. Unless metadata repositories are actively managed and their holdings well-advertised, they will less effective; and subsequent reuse and interoperability goals missed. In addition, it is important that metadata management activities be integrated into other (supporting and supported) processes. This may mean, for instance, ensuring that one of the steps in an "M&S Management Plan" or "M&S Design Document" includes an activity to populate the relevant metadata repository with required data. Overall, key management activities include:

- Administer the metadata repository;
- Query, report and analyse metadata; and
- Oversee metadata distribution and delivery to glossaries and directories.

However, it is important to point out that another aspect of metadata management that can provide critical support is policy. That is, the guidance provided by a government, in this case regarding the management of metadata. For instance, current U.S. M&S policies often include the phrase: "*Information about relevant M&S documents, software, and M&S data shall be made visible for search, discovery, and reuse to promote the sharing of information.*" Such policy pronouncements help to implement effective metadata management practices.

Implementing general metadata best practices will increase the utility of NATO's M&S resource discovery and access. Yet, there are also some more specific actions that NATO can take to improve the likelihood of metadata success. These fall into three basic categories. The first is to continue to postulate options and mature objectives. It is important to refine the envisioned solution set (standards, processes, architectures, etc.) and to further define and update goals and objectives as required. The second set of more specific actions focuses on cooperation, team-building, and socialization. It includes the need to collaborate on possible solutions and to define relative

advantages and disadvantages. It also involves engaging other NATO/PfP Nations to gather their inputs and consider their needs. Finally, it is important to actively participate in implementing process development as well as higher-headquarter discussions.

Finally, it is helpful to consider metadata-specific actions within a long-term time horizon. Associated activities include the need to improve the state-of-the-art through education, outreach, and information sharing and also to forge ahead to enhance technical alternatives and possible solutions. Through working to implement these recommendations in metadata processes, procedures, and best practices, significant progress can be made toward improving NATO and PfP's M&S resource discovery and access.

Chapter 4 – APPLICATION OF PRINCIPLES

M&S resource discovery and access challenges are not trivial and they are not unique to NATO. In fact, the efficient reuse of M&S assets has been a persistent problem for decades. This section of the report summarizes some lessons learned by MSG-100 participating countries and two things are evident. First, it is unlikely that a single technical solution will be sufficient to accommodate all of the needs of each NATO Nation. Second, technological solutions by themselves are unlikely to produce satisfactory results because many of the issues that need to be addressed are organizational or cultural in nature. Therefore, the business processes related to resource discovery and access must also be addressed by NATO.

4.1 PROOF OF CONCEPT

As part of the MSG-100 effort, a proof of concept was conducted to demonstrate processes and procedures necessary to add, edit, discover and remove M&S metadata from existing catalogs. This demonstration had two parts. The first showed how these functions are accomplished within the Data Services Environment and the DoD Enterprise Catalog. The second focused on the ability of an individual Nation – in this case Canada – to perform similar procedures to a different catalog system in order to satisfy a training requirement. The proof of concept was conducted between October 2010 and January 2011. Both experiments were successful.

The first part of this demonstration focused on showing how, using the relationships established in the NATO/DISA MOU on XML Registration (Annex A), it was possible to use the Data Services Environment to perform key M&S metadata interactions within the DoD Enterprise Catalog. Figure 4-1 shows how Data Producers in a COI – including Authoritative Data Sources – publish discovery, structural, semantic, and descriptive metadata for discovery and reuse by both known and unanticipated Data Consumers and End Users. [21]

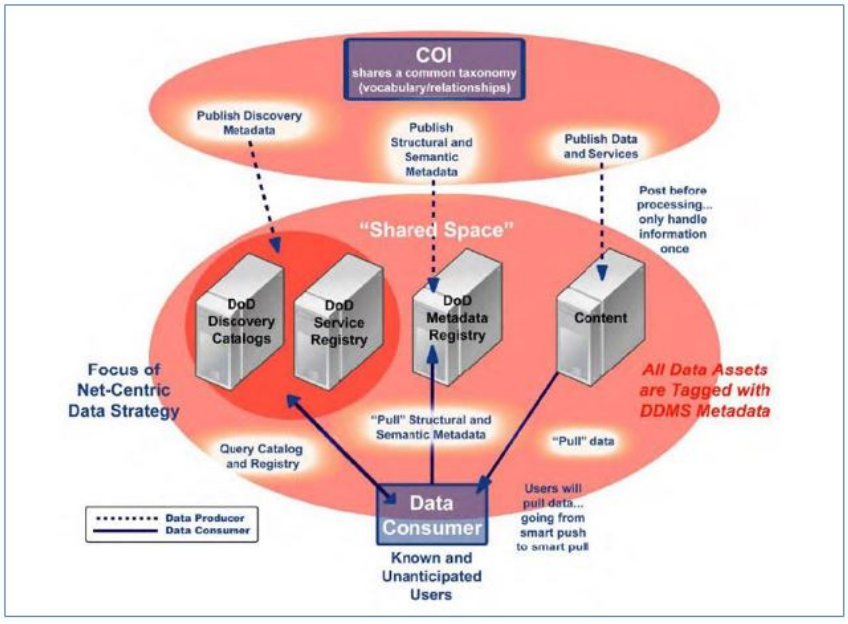

Figure 4-1: Data Services Environment Registry Federation.

A NATO Namespace Manager was appointed and a NATO M&S Namespace was established. The DSE was used to develop metacards in the Defense Discovery Metadata Specification (DDMS) [5] format and sample M&S metadata was added, edited, and removed from the DoD Enterprise Catalog using DSE's publishing and namespace administration capabilities. This successful demonstration showed how users employ the Data Services Environment to conduct essential metadata management functions.

In the second part of this demonstration, Canadian M&S metadata was populated, searched, modified, and restored in support of a notional training exercise. This demonstration leveraged prior M&S metadata developments within the Canadian Department of National Defence (DND), especially a 2009 effort to develop an initial catalog of Army training support systems and DND Synthetic Environment Coordination Office (SECO) 2010 initiatives: "To provide pan-Air Force synthetic environment coordination and to plan the employment and integration of SE resources."

This proof of concept capability, which continues to mature today, used an existing Unstructured Information Management Architecture (UIMA) technology. In UIMA, a set of applications analyze large volumes of unstructured information in order to discover knowledge sought by an end user (Figure 4-2) [1].

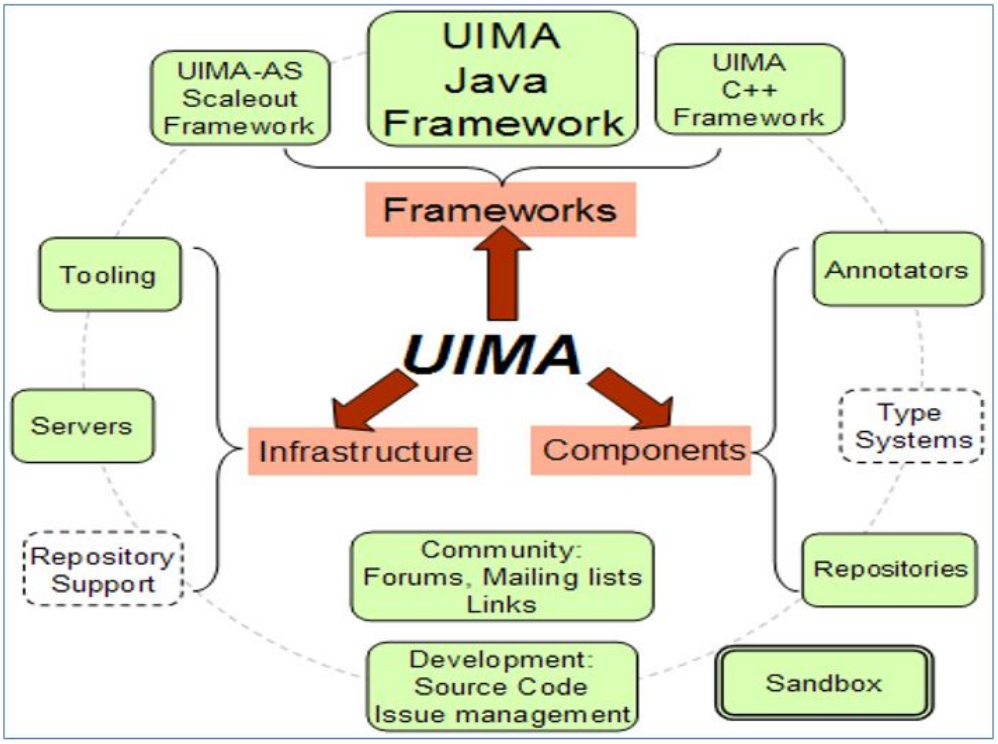

Figure 4-2: Unstructured Information Management Architecture.

The UIMA core was extended via a Local Inventory Metadata Engine (LIME), to specifically apply to M&S metadata. In this part of the proof of concept demonstration, LIME was used to add, edit and remove M&S metadata from an existing catalog. LIME has additional capabilities to update metadata holdings after back-up data sets are created and to harvest metadata from updated M&S training systems upon the conclusion of training exercises.

4.2 LESSONS LEARNED

Both MSG-100 proofs of concept demonstrations were successful; yet underscore some common lessons learned in M&S resource discovery and reuse. The first is that there is a natural tension between global access to data and local control. Enterprises tend to want greater access while specific programs often want to limit asset visibility. The second is that there are significant challenges associated with security and restricted access, which can be especially acute in international settings. The third lesson highlights the inherent differences between generalized ("universally applicable") and tailored solutions. The fourth and final set of lessons learned reflect cultural and business dynamics like the:

- Resistance to outside solutions;
- Desire for local data management;
- Motivation to sponsor known providers; and
- Challenges associated with making significant up-front investments when financial returns are often delayed and can be dependent.[1]

4.2.1 Data Services Environment

The Data Services Environment and Enterprise Catalog are fully operational capabilities that are used daily by DoD organizations to create, store, and manage metadata, as well as to discover useful information about existing M&S assets that are available for reuse. As such, they are used in this report as an exemplar to demonstrate not only the processes and procedures that are used, but also some of roles and responsibilities for positions that would likely need to be staffed and maintained in order to develop a similar capability for a large, distributed organization such as NATO.

While the DSE is a viable technical solution for addressing how NATO could achieve its M&S resource discovery and reuse goals, there are several (non-technical) organizational issues that would need to be addressed when using it or other centralized approaches. For example, at the time of the publication of this report, it is clear that not all NATO Nations would be willing, or able, to store their metadata on a central server hosted by another country, even when a NATO Namespace Manager and Administrator control and manage the data. In addition, using the DSE would require all NATO Members that need access obtain and use a DoD Common Access Card (CAC) and there is no data to suggest every NATO MSG Member desires, or would be allowed, to have and maintain one.

4.2.2 Unstructured Information Management Architecture

The Unstructured Information Management Architecture (UIMA) provides a robust set of capabilities and structures that allows users to search through large amounts of data to find important information and relationships. Such capabilities have been applied text analytics, lexical analysis, and also in cases where it is important to be able to search for concepts and relationships, not solely keywords. This functionality has proven to be valuable within communities as diverse as medical doctors sharing treatment protocols to linguistics professors developing advanced semantic assessment tools.

In the case of M&S resource discovery and access, UIMA enables the development of important capabilities that can be applied to help meet NATO M&S resource discovery and reuse goals – and it continues to add features,

[1] The costs associated with enabling reuse via metadata can take many years to recoup. Also, the degree to which investing in infrastructure to support such reuse is cost effective is likely to be dependent on the number of times the asset is actually reused, thus outside of the control of the metadata community.

like XML Metadata Interchange (XMI) support. However, like any architecture, it must be adapted to a specific domain space. The development of the Local Inventory Metadata Engine (LIME), demonstrated that such an extension could be created to allow M&S metadata to be added, edited, and removed from an existing catalog. Yet like any software system, such extensions must be maintained, updated, and supporting software licenses renewed.

4.2.3 DoD M&S Community of Interest

The DoD's M&S COI was originally established in 2004 and was active for 3 years, helping develop and deploy enterprise capabilities like the High-Level Architecture (HLA). In 2010, the M&S COI was re-activated with a new set of Operating Guidelines and repurposed to address data and resource discovery issues. Although the DoD M&S COI did not participate in the MSG-100 proof of concept, it was active during the conduct of this study and several lessons learned are applicable to future NMSG COI operations.

DoD gives general guidance [8] that successful COIs have the following characteristics:

- Well-defined purpose;
- Clear vision;
- Active engagement;
- Enterprise orientation;
- Capability-based perspective; and
- Suitable projects.

However, experience has shown that even when these characteristics are present, the NMSG COI may encounter a number of challenges. There are few enterprises more diverse and distributed than DoD, but NATO is certainly one of them. As such, the technical problems addressed by the COI will be complex, as are the potential difficulties in resolving organizational and cultural issues. The following best practices on COI composition, organization, and operation are important considerations toward assuring the NMSG COI is not only active and effective, but also productive.

The NMSG COI must be firmly grounded in both NATO M&S Policy and Strategy. Operating Guidelines that summarize the roles, responsibilities, and administrative procedures for the conduct of business in the must be developed and made available to all participants. The guidelines also explain how the COI interacts with the NATO governance structure and performs cross-domain collaboration with other COIs, like the DoD M&S COI.

A clearly articulated set of governance-approved objectives and an organizing structure that facilitates achieving those objectives is imperative. DoD guidance on COI structure and calls for governance processes that enable the establishment of working groups, as needed, to address COI focus areas. For example, a more specific recommendation is that a COI "might task a data working group with developing COI categorization schemes, thesauri, vocabularies, and taxonomies."

In 2010, the newly created M&S COI Data Management Working Group (DMWG) was created and designed around three Capability Development Teams. The Discovery Metadata Team focused on discovery metadata, including the M&S COI Discovery Metadata Specification (MSC-DMS) [9], which is the M&S domain extension to the DDMS, as well as resource discovery through catalogs. The Enterprise Data Team addressed structural and semantic metadata, and was focused on the use of DSE tools and procedures, as well as DSE as a

registry. It also tracked and reported on new and emerging data frameworks and exchange models, such as the National Information Exchange Model (NIEM). Finally, the Enterprise Services Team was concerned with documenting Information Technology (IT) services, the descriptive metadata that describe them, and reuse of web services in the M&S enterprise.

It is the nature of COIs to change over time in order to address new and emerging technical challenges and the DoD M&S COI has been both scalable and extensible. Working Groups and Capability Development Teams have been established and disestablished over time. An example is the recent addition of an Architecture Working Group, tasked with developing the M&S Domain Reference Architecture. Agility and flexibility are important characteristics of successful COIs.

Finally, achieving appropriate levels of participation from a wide variety of Subject-Matter Experts (SMEs) is critical. COIs should be composed of an appropriate mix of personnel from Government, industry, and academia, as well as members from other closely-related COIs. However, many COIs are “coalitions of the willing”, meaning member participation is not funded. It can difficult to obtain sufficient participation under these circumstances and even more challenging to maintain consistent participation for the extended periods of time needed to make sustained progress on long-term enterprise problems like M&S discovery and reuse.

Chapter 5 – RECOMMENDATIONS

The MSG-100 effort had in its objectives the requirement to provide a set of applicable M&S resource and access recommendations. So, now that the history, purpose, and scope of the MSG-100 have been described and applicable organizations, activities, and use cases discussed it is useful to provide these recommendations. They apply to discovery metadata standards and specifications; business and COI initiatives; and NSRL enhancements.

5.1 PROMOTE ADOPTION OF M&S DISCOVERY METADATA STANDARDS

NATO M&S developers and users can be strong advocates of discovery metadata standards, if these professionals know what they are, understand what they can do, and appreciate their value. Similarly, these standards will be increasingly embraced if M&S leadership advocates, directs, and recognizes advancements in this area. Finally, such standards will be used more often if there are organizations in place that foster, facilitate, and coordinate their development and application. An overview of key components is provided in Figure 5-1 [22].

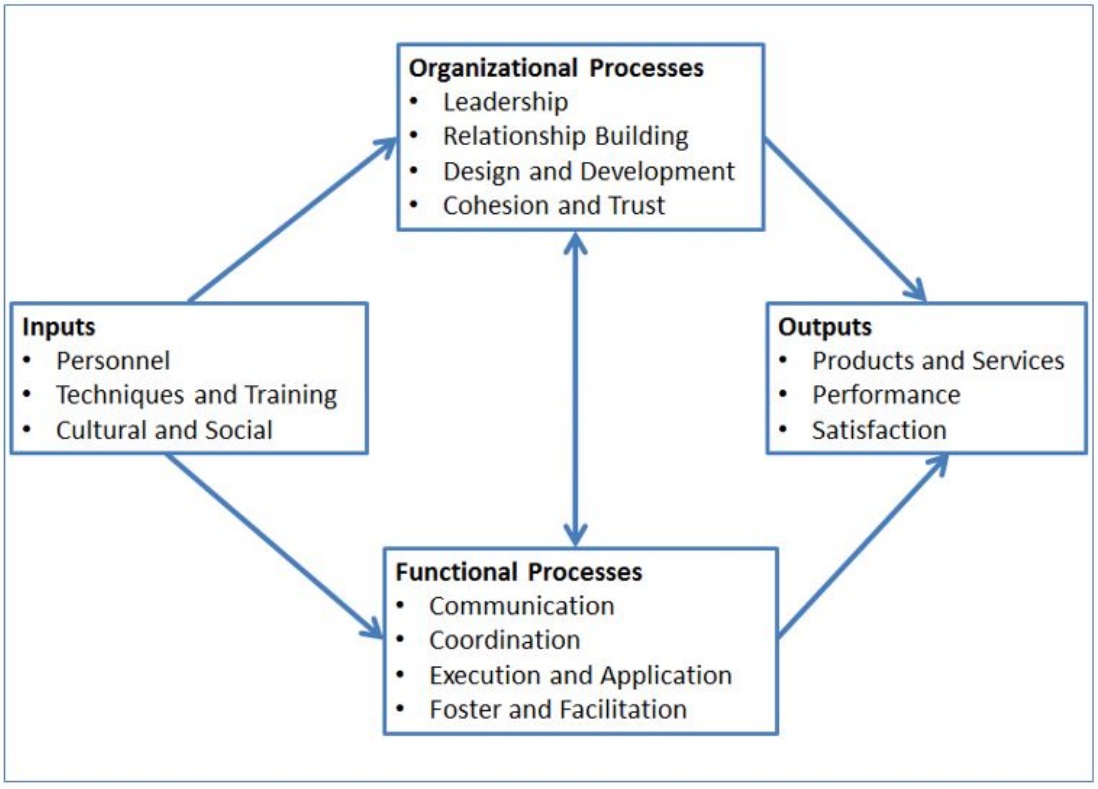

Figure 5-1: Key Features and Functions of M&S Adoption.

For the NATO M&S Community to adopt and expand the use of discovery metadata standards, two major groups of developers and users need to be informed. The first are those M&S students and practitioners who are expanding their knowledge-base and skills. For this group, courses and tailored classes need to be offered within

traditional educational settings (e.g., colleges and universities), as well as during M&S conferences, meetings, and events. Knowledgeable and well-educated developers and users are most likely to understand and appreciate the value of discovery metadata and the reuse it allows. The second group that needs to be made aware of discovery metadata standards is program, technical, and applications-oriented managers. For these individuals, who are working within extreme time and budget constraints, carefully targeted advice is warranted. Such advice can take the form of "Tiger Teams" that respond to particular M&S resource discovery issues and "Advance Teams" that take the initiative to contact these managers to offer direct assistance.

There is also a critical role NATO M&S leadership can play in increasing discovery metadata capabilities and use. They can use their position to articulate the benefits and to motivate their institutions to employ such standards. Leadership can also establish organizational and programmatic goals, metrics [24], and success criteria. As part of their organizational goals, leaders can support and give legitimacy to requisite integrated product teams, working groups, and COIs and can help to ensure coordination among and between these groups. Finally, leadership can promote the adoption of policies that support M&S discovery metadata development and adoption. These types of actions would assist in:

- Promoting interoperability and the use of common M&S capabilities;
- Minimizing duplication and encouraging reuse;
- Supporting needed R&D initiatives (e.g., on semantic metadata/data); and
- Encouraging all NATO/PfP Nations to leverage each other's M&S resources and capabilities.

In addition to informed M&S professionals, leadership support, established product teams and working groups, the adoption of discovery metadata will also improve with coordination, dialog, and knowledgebase development. Such coordination and dialog is especially important between NATO/PfP Nations, but it also needs to include every country's industrial base, government services, and academic community. Each has an important role to play and intellectual content to contribute. These contributions, along with peer-reviewed pedigrees, employment concepts, and lessons learned, will need to be gathered, indexed, and made available for future use.

Along with these key initiatives, it will continue to be important to develop, field, and update prototype capabilities. Discovery metadata standards are more likely to be used, extended, and populated if potential users have a nascent capability to explore and understand. Such investigations results in a more knowledgeable user base, with a better appreciation of the potential of such a capability; and that often leads to advocacy. Discovery metadata standards are more likely to be used, extended, and populated if potential users have a nascent capability to explore and understand the needs those standards have to meet.

In the area of business, this could include formalized and tested contracting approaches, intellectual property rights language, and cost reimbursement mechanisms across NATO/PfP. Relative to deployment concepts, templates for infrastructure, architecture, and security protocols could be developed for "off-the-shelf" use. Commercial contributions and deployment considerations are often critical to the successful adoption of emerging technology standards. Finally, as in many instances of motivating human behavior, acknowledging success is important. Such recognition could take the form of NATO/PfP-wide appreciation, country-specific acknowledgement, or the recognition of a specific application's excellence.

NATO M&S community members are likely to promote the adoption of discovery metadata standards if they:

- Understand how it will improve the products they deliver;
- Receive support from their leadership;

- Establish the needed management and coordination activities; and
- Formulate the enabling business, infrastructure, and security protocols.

5.2 UPDATE NATO'S M&S DISCOVERY METADATA SPECIFICATION

The NDMS (version 2D5) closely resembles a previous version of the U.S. DoD DDMS Version 2.0. The newest DDMS Version is 5.0 [25]. Many of the newer features of DDMS 5.0 are recommended as useful updates to future editions of the NDMS. In general, there are three general categories of update requests:

- First, there are those that seek to satisfy user requests for increased functionality;
- Secondly, there are updates to stay in alignment with DDMS and similar standards; and
- Thirdly, the M&S metadata specification must respond to changes to the enterprise infrastructure, such as changes to metadata catalogs which collect metadata, index them, and make them searchable.

More specifically, one key requirement for future NDMS releases is the more complete instantiation of security features. There is a need for significantly enhanced security and releasability mark-up tags. In addition, it is important to include an information element that describes the metacard distinct from the asset being described. New fields can be added to collect information about the metacard to support proper collection in a catalog. For example, this permits one person to be the "owner" of a model but another to be the "owner" of the metacard describing the model. This is helpful because in many cases, the model owner is typically the senior developer while the owner of the metacard is the sponsor or someone with acquisition responsibility. This update in functionality would encourage collaboration between technical and acquisition teams.

There is also a need to associate related resources, such as linking a model with its original requirements document. This is especially useful for configuration management purposes where the two need to match. Also, a model might also be linked to its verification and validation plan or accreditation document. This is an important capability because the decision to potentially reuse a model is likely to depend heavily on the artifacts that are related to that model.

Another suggested feature to include in future NDMS upgrades is the capability to add "user ratings", which provide qualitative assessment of the usefulness of a resource. This feedback could take two forms. The specification could permit the selection of a "star" rating, in which the specification simply provides a data element that captures a user's experience with the tool on a scale of 1 to 5 stars. A rating of 5 stars would indicate a highly favorable experience with that M&S resource. A second mechanism that could be provided in the specification is an area for "user comments". This type of feedback provides a data element for the user to generate narrative comments based on their experience with the M&S resource. These comments can be appended to the metacard and can be valuable information to help practitioners make judgments about the suitability of an M&S resource for reuse.

Finally, it is important to point out that the current NDMS lacks "explicit formal semantics which are crucial in order to perform semantic service discovery through the use of machine interpretation and reasoning." [12] Such semantic content will be especially important as the NATO/PfP M&S community strives for composable simulation federations. However, this recommended update will take many years to fully implement and thus should be considered early in the next NDMS update cycle.

5.3 EMPLOY BUSINESS MODELS TO PROMOTE M&S REUSE

An overall business model describing the NATO/PfP M&S marketplace contains the standard components of buyers and sellers who transfer goods and services in exchange for compensation. However, in this environment buyers are not paying sellers directly and the meaning of compensation refers to future cost savings and not a transfer of funds. Also, the focus on resource discovery and access adds an important feature to this business model (Figure 5-2) [23]. Discovery allows consumers to find and reuse M&S assets.

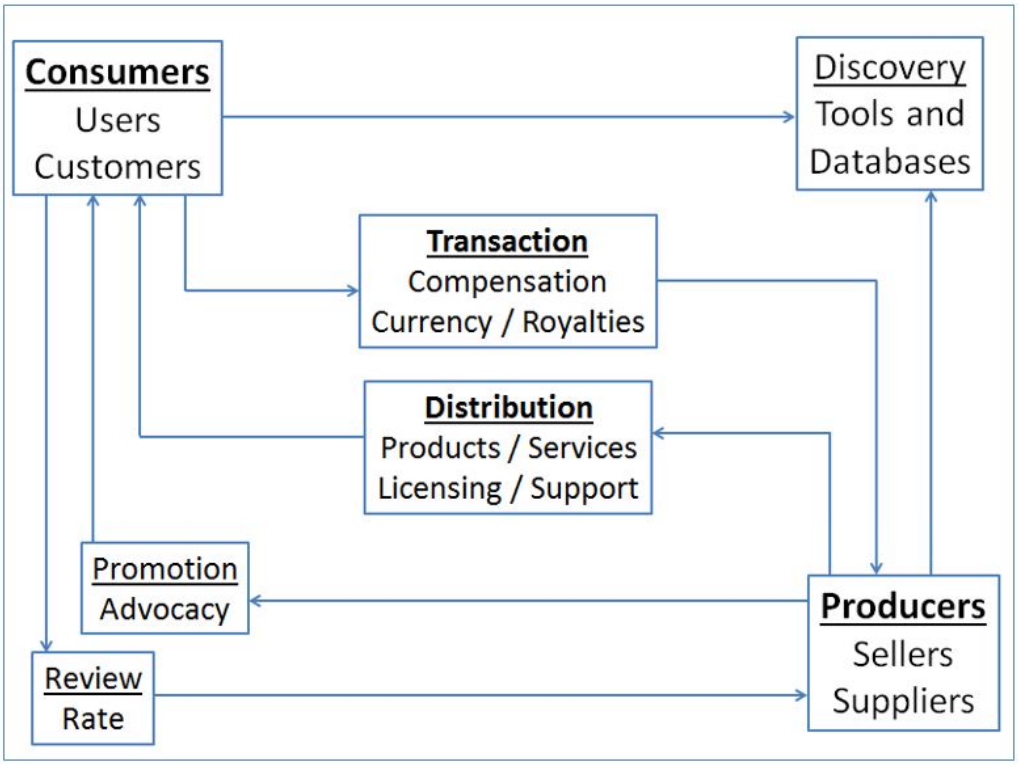

Figure 5-2: M&S Business Model Including Discovery.

Resource discovery, via interface tools to current M&S databases, can significantly facilitate the reuse of M&S assets. They allow an easy and unfettered access to information on M&S capabilities that have the potential to be used again within other application domains, mission areas, levels of analysis, and similar. Although promoting M&S reuse, like adopting discovery metadata standards benefits from an informed user-base, proactive leadership, policy direction, effective coordination, and success acknowledgement are important, there are additional business-oriented actions that can be taken.

First, a business case can be developed and presented to M&S producers that will demonstrate the commercial benefits of making their resources discoverable to potential users. Such an argument could emphasize the degree discovery would augment normal advertisement and public awareness initiatives. The result for the NATO/PfP M&S community would be a greater number of discoverable assets and thus an increased likelihood that some of them would be reused. Second, an additional business case could be written, but this time for consumers. For consumers, the emphasis could be on the likely cost and time savings, risk reduction, and product improvements from adding the step of resource discovery to the front-end of their software development

lifecycle. The result here would be an increased probability that potential users would seek to discover potentially reusable assets. Third and finally, those in the M&S community that promote capabilities or review resources could add to their discussion a section on the value of reuse. This could take the form of business developers describing past successes or reviewers rating programs using a reuse metric.

Another type of business model exploits the cost of search/evaluation versus the cost of fabrication. This is a competitive strength area for M&S repositories. In general, most M&S practitioners hold that simulation is just a model of some aspect of a real system. Depending on the purpose of the model, and due to resourcing constraints, model boundaries will be drawn so that a reasonable representation of a real system can be obtained. Therefore in theory, most models of sufficient complexity cannot be used interchangeably without an evaluation that involves some level of testing and analysis. Testing and analysis takes time and effort. Fabrication also takes time and effort. To a simulation provider, search/evaluation versus fabrication is a classic "build vs. buy" decision. In most cases, a simulation provider, when faced with a "build vs. buy" decision, will almost always "build". The reasons are two-fold:

- First, the cost of building is generally known since the builder has full control over the boundary of the model; and
- Second, if a simulation provider foresees any risk due to an unforeseen requirement within their simulation model, they will almost always default to "build" just so that they have the option of adjusting their custom built model.

In contrast, "buying" a simulation model involves searching and evaluating amongst alternatives. In today's world, "search" is well understood as a result of commercial entities such as Google. Evaluation is a more difficult domain. As an example, consider a car as an 'asset'. A common commuter who is buying may evaluate criteria such as price, features, cost of maintenance/operation and image to arrive at an overall determination of value. On the other hand, a dealership who is selling cars might use evaluation criteria such as margin, saleability, and inventory costs in determining what assets they will make available. In order for an asset to change hands, both sellers and buyers must have enough information at their fingertips to risk the transaction. This is an area where M&S repositories have a competitive strength. Only a repository can hold the information required by both 'buyers' and 'sellers' of an asset. The competitive strength of a repository is the ability to capture the metadata, and only the metadata required to effect a transaction.

Another type of business model to consider in the promotion of M&S resource reuse is one that focuses more closely on relating consumers to producers through the metadata catalog (Figure 5-3). In it, the focus is on the relationship of consumers and producers specifically relative to the metadata catalog. This is another case in which an informed user-base, proactive leadership, policy direction, effective coordination, and success acknowledgement are important, but there is more that can be done. For instance, consumers and producers can work more closely together to understand current strengths and limitations within organizations and activities relative to reuse. They can discuss key issues like intellectual property. Producers have an incentive to closely guard trade secrets, proprietary systems, and processes that yield a competitive advantage. Consumers desire flexibility, permissive licensing, and total life-cycle cost reduction. Business rules can be developed that protect and benefit both parties, yet one key initial step is an understanding of the internal dynamics and success criteria present within each group. With that understanding, additional steps to promote reuse can be more effectively developed.

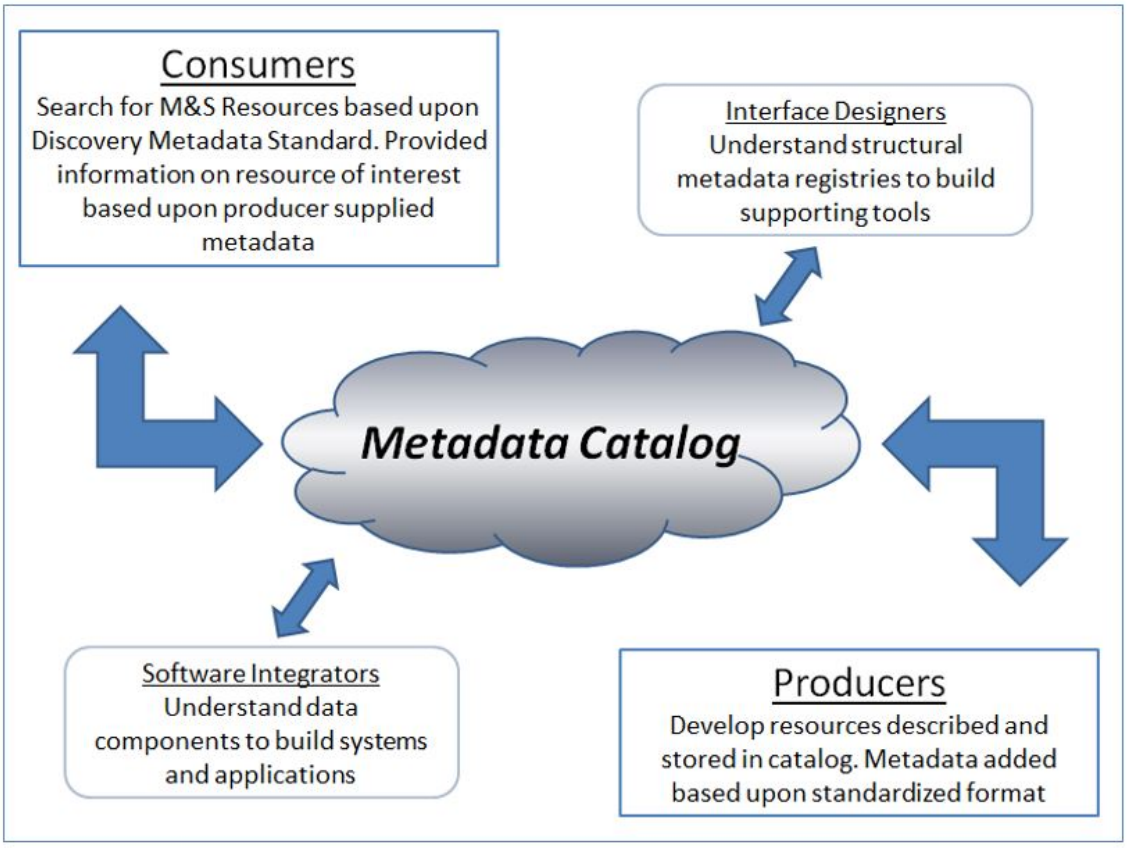

Figure 5-3: Relating Consumers and Producers via Metadata.

Along with promoting reuse via the mechanisms inherent within M&S business models, it is also important to summarize how the adoption of the Discovery Metadata Specification (DMS) itself could enable increased software reuse. A mature DMS:

- Lowers barriers to updating metadata, thus making it more likely data will be current;
- Provides users key fields of interest, thus making their searches more effective;
- Allows access controls and segmented access, thus allowing appropriate security;
- Permits federated, complex/Boolean searches, thus providing tailored results; and
- Embodies stability within an extensible framework, thus is consistent yet adaptable.

As the DMS is increasingly adopted, M&S resource reuse becomes more efficient. There are more assets to choose from and so it is more likely that the capability need and the resource previously developed will match. In addition, as the DMS is employed, greater consistency in descriptions will make finding potential reusable resources easier. This capability will replace the need to search through multiple M&S user guides, each with their own format, to find out what a specific section of code actually does. Finally, increased adoption of a stable DMS will mean increased numbers of user interfaces, automated population tools, and automatic output reporting algorithms. Each will significantly reduce the level-of-effort required to discover recyclable resources, thus improving software reuse.

5.4 ESTABLISHING COMMUNITY OF INTEREST GOVERNANCE

Several COI concepts were summarized in Chapter 2, including how different types of metadata are related to catalogues, registries, and repositories, and how these may be collectively applied toward addressing net-centric data and IT service sharing strategies. Best practices for establishing a COI were also given and the roles and responsibilities of COI participants were defined. Section 4.2.3 summarized lessons learned from DoD M&S COI meetings held during the same time period as this study, including an organizational structure based on Technical Working Groups, like the Data Management Working Group, and its component Capability Development Teams, that specifically address resource discovery, understanding, and reuse.

Equally important, and summarized here, are the non-technical aspects of COI operation, including governance procedures. Governance is an important aspect in achieving levels of M&S interoperability required by NATO. Perhaps a good example is the NDMS. From a technical perspective, it is relatively easy to develop NDMS as an XML schema, based on an existing DDMS. Typically, it is more difficult to develop the necessary policy, operational and sharing agreements, and successful votes required for the adoption of NDMS by NATO Nations.

It is a fundamental tenant that the NMSG COI must be firmly grounded in both NATO Policy and M&S Strategy and the COI governance structure enforces these links to policy and strategy. COI governance also develops and promotes the business models described above, endorses resource discovery, reuse goals and objectives, and approves the technical processes and procedures developed by working groups to obtain those goals. Perhaps most important, COI governance works with NATO to develop the memoranda of understanding and the data and national sharing agreements required to enable reuse between participating countries.

Governance of COIs and their activities is performed by Steering Committees and Executive Boards that focus on business aspects and execution, rather than technical issues that are addressed by working groups. The Steering Committee identifies the COI mission and information sharing needs. It ensures adequate stakeholder participation and appoints governing authority representation to working groups and teams. The Steering Committee promotes policies and practices for resource sharing, identifies success criteria for the COI and tracks action plans, metrics, and milestones. The Executive Board meets less frequently, promotes and endorses COI activities and implements agreements as necessary to facilitate collaboration and accomplish assigned tasks, and reviews and approves action plans and milestones [21]. As shown in Figure 5-4, in some cases the Steering Committee and Executive Board can be collapsed into a single governance group. However it is structured, the NMSG COI governing authority is the COIs external champion and must have the authority to develop international agreements and effect recommended change.

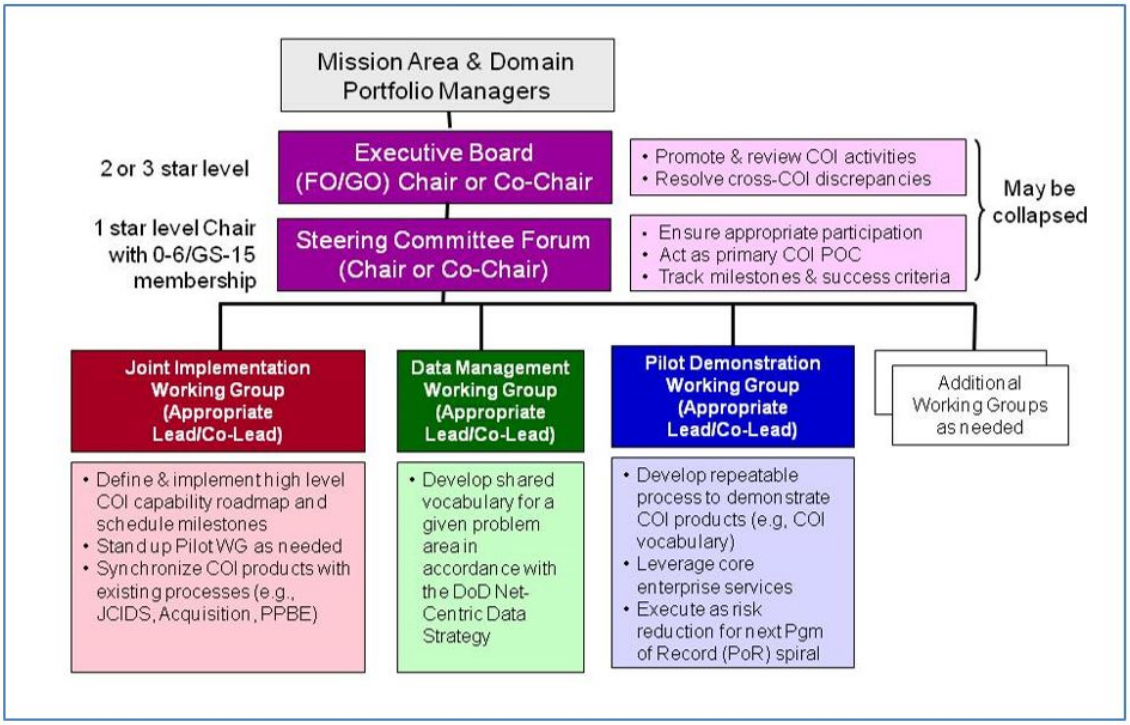

Figure 5-4: Sample COI Governance Structure.

5.5 MATURE THE NSRL INTERFACE SPECIFICATION

In 2007, the NATO/PfP M&S community in 2007 successfully conducted a series of tests and demonstrations to generate feedback and begin the process of populating the NSRL [14]. As this capability moves forward, it is very important that it stays consistent with the periodic upgrades of the NDMS. This is especially true as the volume of metadata and the number of data producers increases. In such cases it will be critical to exchange data more efficiently through the use of automated mechanisms such as web services. These interfaces permit rapid exchange and ingestion of metadata into the library and also preclude errors introduced by human manipulation of the data.

A tight association also allows future enhancements made to the NDMS to be made available to the NSRL environment. These include a more complete instantiation of information assurance features by including security and releasability mark-up tags, an information element that describes the metacard distinct from the asset being described, a mechanism that allow the association of related resources, and an ability to allow users to rate the resources within the library.

Stability can also be enhanced through an emphasis on discovery metadata as a key prerequisite capability. Some of the initial challenges that surfaced with the release of the NSRL had to do with gaining access to the resources themselves. It can be very beneficial to clearly and consistently separate the development of discovery metadata and its placement into an M&S catalog from access to an M&S asset residing within a repository (Figure 5-5). Intellectual property concerns are significantly less of an issue when posting discovery metadata. When the discovery capabilities of the catalog are mature, then subsequent choices can be made about asset access.

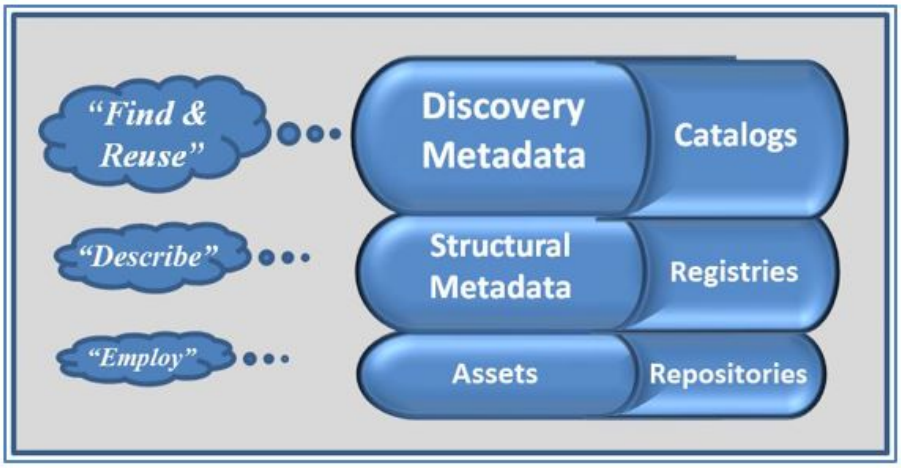

Figure 5-5: Discovery and Access Levels.

Finally, it is important in the life-cycle of any interface specification to take into account advancements and newly recognized requirements. This is especially true in a setting like NATO/PfP. Each country and partner has a unique M&S environment within which to work, and therefore may have different priorities or different needs within systems that support resource discovery and access. For instance, the United Kingdom is actively pursuing accurate and complete metadata to document "climate modeling results" and has established an associated metadata catalog. [10] Spain, France, and others are members of the Drug Disease Model Resources consortium developing M&S systems and associated metadata. These are just two examples of many such programs, project, and efforts within NATO/PfP. Such initiatives and technological advancements need to be considered in the conceptual NSRL interface specification. [11]

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Annex A – DISA/NATO MOU

MEMORANDUM OF UNDERSTANDING (MOU)

BETWEEN

NORTH ATLANTIC TREATY ORGANIZATION (NATO) HEADQUARTERS

CONSULTATION, COMMAND AND CONTROL STAFF (NHQC3S)

AND

DEFENSE INFORMATION SYSTEMS AGENCY (DISA)

ON

SUBJECT: NATO Extensible Mark-up Language (XML) Registration

1. **Purpose**. Without establishing legally binding obligations, this Memorandum of Understanding (MOU) documents the understanding between North Atlantic Treaty Organization's (NATO) Headquarters Consultation, Command and Control Staff (NHQC3S) and the United States Department of Defense (DoD) Defense Information Systems Agency (DISA). DTSA will provide NHQC3S access to the unclassified 000 Metadata Registry (MDR) storage space for the registration of unclassified NATO Extensible Mark-up Language (XML) components.

2. **Background**. The NHQC3S Data Administration (NDA) staff is tasked to establish and run a NATO XML Registry that contains all NATO XML namespaces and provide functionality to technically maintain and publish these namespaces. The NATO Data Administration Group (NDAG) is tasked to supervise operation of the NATO XML Registry and to perform registry-related activities as required. The NDAG is tasked to be the "owner" of the NATO Enterprise Namespace. Because the NDA staff is not resourced to support this effort, it has requested support from the member nations to host the initial NATO XML registry. In response, the United States (US) has offered to support this effort to promote the highest degree of interoperability possible between the US and NATO and establish US XML practices as the NATO baseline. The DoD Metadata Registry (http://metadata.dod.mil) and metadata registration processes are part of the overall DoD Net-Centric Data Strategy, and they have been established for the collection, storage, and dissemination of structural and semantic metadata information resources. This web-based DoD metadata repository is designed to act as a clearinghouse and coordination center for industry and government metadata technology and related issues. DoD CIO and USD-AT&L designated the Defense Information Systems Agency (DISA) as the Executive Agent (EA) for establishing, in coordination with DoD Components, the DoD XML Registry and Clearinghouse.

3. **Scope**. This MOU defines parameters for NATO access, operation, and maintenance of space allocated in the DoD Metadata Registry for registration of NATO XML components.

4. **Responsibilities**.

a) DISA will:

i) Provide DoD Metadata Registry service to NATO within 120 days of the effective date of this MOU.

ii) Establish NATO Namespaces on the DoD Metadata Registry.

iii) Publish a protocol that allows allied government personnel with "NATO.int" addresses to access the DoD Metadata Registry. Access to the DoD Metadata Registry requires a .gov or .mil or NATO.int address or sponsorship by a .gov or .mil address.

iv) Grant limited "write" privileges to NATO personnel sufficient to register and administer NATO metadata held within the DoD Metadata Registry.

v) Provide access to the DoD Metadata Registry via userid/password, however, DISA's plan, per DoD requirements, is to move to DoD PKI enablement which will require further negotiations between NATO and DISA regarding access to the DoD Metadata Registry.

vi) Provide a configuration management process that informs owners of DoD Metadata Registry Namespaces of changes.

vii) Include the NATO Enterprise Namespace manager in its DoD Metadata Registry focus group forum.

b) The NHQC3S will:

i) Govern NATO processes for XML Registration in the DoD Metadata Registry.

ii) Generate, submit, and manage NATO submissions to the DoD Metadata Registry.

iii) Execute configuration control over components registered in the NATO Enterprise Namespace.

iv) Develop and maintain procedures for the harmonization of NATO Namespaces and facilitate specific harmonization efforts with DoD where appropriate.

v) Coordinate as required with appropriate NATO security organizations to address DoD Metadata Registry access controls.

vi) Acknowledge that implementation of DoD PKI access to the DoD Metadata Registry will change the current access and approval mechanism from userid/password to PKI access.

vii) Provide NATO XML expertise as available to expand online technical support for DoD Metadata Registry users, especially for answering questions concerning NATO metadata holdings.

viii) Every 12 months, review the NATO registration effort to identify which elements of registry capability, if any, it may choose to provide for itself or obtain from other sources.

ix) Provide all required NATO branding and marking for DoD to use.

x) Coordinate XML Registration with DISA.

xi) Provide the namespace manager for the NATO Enterprise Namespace.

xii) Be the single Point of Contact for NATO XML and other metadata registration issues.

5. **Implementation**.

a) Effective Date: This MOU becomes effective upon the date of the last approving signature and will remain in effect until superseded, amended, or terminated.

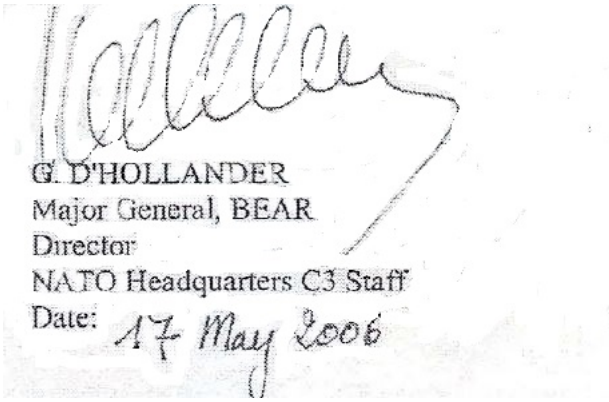
b) Termination: This MOU may be terminated by mutual agreement of the signatories or by either party by providing written notice to the other party.

c) Amendments: This MOU may be amended at any time by mutual consent of the signatories.

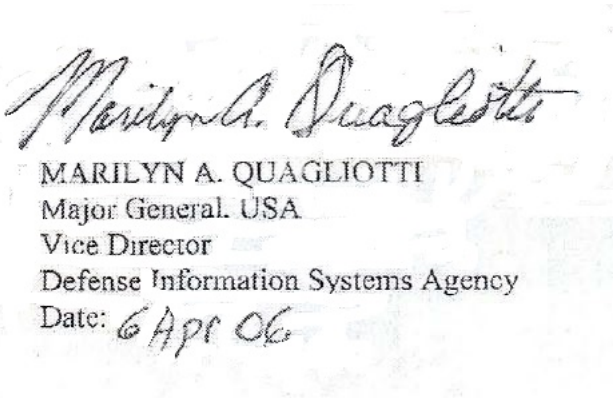
d) Annual Review: Review of be provisions of this MOU will be made annually at least l20 days before the anniversary of the effective date.

e) Disputes: Any dispute regarding the interpretation or application of this MOU shall be resolved by consultation between the parties.

APPROVED



G. D'HOLLANDER
Major General, BEAR
Director
NATO Headquarters C3 Staff
Date: 17 May 2006



MARILYN A. QUAGLIOTTI
Major General. USA
Vice Director
Defense Information Systems Agency
Date: 6 Apr 06

COORDINATED:

DOD DCIO

NDAG

Appendix A1 – DESCRIPTION OF DoD ENTERPRISE CATALOG AND DATA SERVICES ENVIRONMENT (DSE)

The DoD Data Services Environment (DSE) contains the structural and semantic metadata artifacts critical to successful development, operation, and maintenance of existing and future capabilities that support the DoD Net-Centric Data Strategy. It is maintained and operated by the Defense Information Systems Agency (DISA) under the direction and oversight of DoD Chief Information Officer (CIO). The DSE exists to simplify the publication and discovery of data services that facilitate information sharing across the DoD and revolves around the goals of DoD Net-Centric Data Strategy (NCDS), requiring that data be made visible, accessible, understandable, trustworthy, and interoperable.

The DSE functions as an integrated dashboard that combines the capabilities of the Metadata Registry (MDR), Net-Centric Publisher (NCP), Service Discovery (SD), and the Enterprise Authoritative Data Source Registry into a common modular framework. It provides a single point of access to DoD data source directories to improve search, access, consistency, and integration of data services as well as to increase collaboration amongst data producers and consumers. This is promoted by:

- Acting as a key enabler to make data "visible, accessible, and understandable";
- Providing greater data visibility and accessibility by implementing an Enterprise service;
- Streamlining search and access; and
- Providing a set of tools to register and discover data services across the Department.

The DSE is made up of several different components, including the Enterprise Service Registry (ESR), which is designed to support unique underlying requirements, models, users and workflows. The DSE publish feature provides users a clear set of workflows from a single interface point for publishing, managing and governing their assets that include:

- Semantic metadata artifacts such as service interface specifications, i.e., WSDL files, supporting message formats, i.e., XML Schemas, as well as descriptive and informative documentation supporting those assets;
- Services and service metadata including service end points, service POCs, and service PMO;
- Authoritative data sources including systems, data stores and capabilities that fulfill particular data needs; and
- DDMS records that include the core discovery information required by the DDMS Specification and publish that information to the enterprise catalog.

The following table lists the standard features and functions available via the DSE user interface.

Table A1-1: Standard Features and Functions Available via the DSE User Interface.

Feature	Function
Discover	Search metadata (schemas, taxonomies, Web Services Description Languages [WSDLs], Extensible Mark-up Language [XML], access control policies, style-sheets, data structures, etc.), services, providers, namespaces, Communities Of Interest (COI), and authoritative data sources.
Publish	Publish NEW metadata, services, providers, Enterprise Catalog, namespaces, COIs, and authoritative data sources.
Services	Provides various views on top of services and providers.
Governance	Provides various views of governance structures, like namespaces, COIs, mission areas, domains, and governing authorities.
Metrics	On metadata, activity, and service management.

The DSE is a central, federation-capable site for the publication and distributed management of metadata. It is a virtual "place" where collections of metadata components, in which DoD organizations and others have invested, can be:

- Published, visible, accessible, and understandable to large audiences;
- Transparently and collaboratively evolved and otherwise managed by representatives of a large, diverse, and geographically distributed group of people and organizations;
- Monitored to determine contextual relevance (importance/priority), quality, usage, and other factors that affect engineering and resourcing (future investment) decisions; and
- Exploited by the machine-to-machine process in support of such functions as validation and transformation.

DSE is the DoD's designated enterprise tool for worldwide content discovery. It allows the users to define their search criteria and discover content provided via a centralized search engine, federated data sources, and the Enterprise Catalog.

The DSE acts as a key enabler to make data visible, accessible, and understandable. It provides:

- Greater data visibility and accessibility by implementing an Enterprise service;
- Reduces cost and improves timeliness through the consolidation of Authoritative Data Source;
- Eliminates the need to stand up and manage individual registries' streamlines search and access; and
- Provides a set of tools to register and discover data needs, data sources, and data services across the DoD.

Appendix A2 – DoD NET-CENTRIC DATA STRATEGY (NCDS) AND GOALS

In May of 2003, the DoD Chief Information Officer (CIO) signed the DoD Net-Centric Data Strategy (NCDS) [6]. Subsequently, DoD Directive 8320.02 [7] was signed in December, 2004, directing the implementation of the NCDS, followed by DoD Guide 8302.02-G being signed in April, 2006, providing guidance for its implementation. Finally, in August of 2013, DoD Directive 8320.02 was reissued as DoD Instruction 8320.02, establishing policies, assigning responsibilities, and prescribing procedures for securely sharing electronic data, information, and IT services and securely enabling the discovery of shared data throughout the DoD.

The DoD NCDS lays down the foundation for managing the Department's data in a net-centric environment. Significant attributes of the data strategy include:

- Ensuring that data assets are visible to the widest possible audience and accessible on demand, so that they are available when and where needed to both known and unanticipated users.
- Categorizing and tagging data assets (raw and processed) with well-managed metadata that supports rapid and precise discovery.
- Making data assets as understandable as possible through publication of rich descriptive metadata and trustworthy by providing pedigree information, including producer POCs as well as security arrangements that foster data integrity.
- Posting data to shared spaces such that ultra-large user groups can efficiently access them, except when limited by security policy or other regulations.
- Posting in parallel with processing; Task-Post-Process-Use replaces the Task-Process-Exploit-Disseminate paradigm. Even data that is extremely raw and ambiguous to first phase analysts may have great significance is some user contexts.
- Separating data from applications to enable repurposing; users may choose different applications to exploit the same data. Increase the variety of ways as well as numbers of users that capitalize on DoD-produced data improves the Department's ROI in information resources.
- Handling information only once to improve efficiency and reduce duplicative, non-authoritative data goes hand-in-hand with repurposing. Validated user identities for example can be applied to a wide range of purposes from financial and personnel record keeping to security. Avoid creating redundant information sources or caches where possible.
- Pro-actively collecting user feedback on data asset quality and responsive to needs as well as instrumenting to collect empirical usage data. Monitoring audience response and obtaining hard empirical performance data is keep to optimization. User satisfaction should be the main objective of every information producer.

Another key point of the NCDS is that it changes the paradigm of standardizing data elements across the DoD to the management of data within Communities of Interest. The Strategy fosters a "many-to-many" exchange of data, which will allow multiple users and applications to share and leverage the same data. The following table provides the goals of the NCDS.

Table A2-1: Goals of the NCDS.

Data Goal	Description
Visible	Users and applications can discover the existence of data assets through catalogs, registries, and other search services. All data assets (intelligence, non-intelligence, raw, and processed) are advertised or "made visible" by providing metadata, which describes the asset.
Accessible	Users and applications post data to a "shared space." Posting data implies that: (1) descriptive information about the asset (metadata) has been provided to a catalog that is visible to the Enterprise; and (2) the data is stored such that users and applications in the Enterprise can access it. Data assets are made available to any user or application except when limited by policy, regulation, or security.
Institutionalize	Data approaches are incorporated into Department processes and practices. The benefits of Enterprise and community data are recognized throughout the Department.
Understandable	Users and applications can comprehend the data, both structurally and semantically, and readily determine how the data may be used for their specific needs.
Trusted	Users and applications can determine and assess the authority of the source because the pedigree, security level, and access control level of each data asset is known and available.
Interoperable	Many-to-many exchanges of data occur between systems, through interfaces that are sometimes predefined or sometimes unanticipated. Metadata is available to allow mediation or translation of data between interfaces, as needed.
Responsive to User Needs	Perspectives of users, whether data consumers or data producers, are incorporated into data approaches via continual feedback to ensure satisfaction.

Section 2.1.2 of the DoD NCDS discusses the development, use, and management of Metadata within the DoD Net-Centric environment.

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NATO Network-Enabled Capability (NNEC)
NATO Simulation Resource Library (NSRL)
NATO XML Management Services Working Group (NXMLSWG)
Net-Centric Data Strategy (NCDS)
Resource discovery
Unstructured Information Management Architecture (UIMA)

14. Abstract

The process of developing models and simulations "from scratch" is a challenging endeavour, requiring technical as well as subject-matter expertise. Improving the ability to discover existing modelling and simulation resources has the potential of saving valuable time and cost through reuse. This report summarizes technical, managerial, and infrastructure components of M&S discovery and access, including best practices and lessons learned, and recommendations follow on efforts to:

- Develop an active and effective NATO MSG Community Of Interest (COI) to address reuse;
- Promote the adoption of an M&S discovery metadata standard;
- Update NATO's M&S Discovery Metadata Specification (NDMS);
- Develop and employ business models to promote M&S reuse;
- Enhance the NATO Simulation Resource Library (NSRL); and
- Mature the NSRL interface specification.

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